Tappi

PUBLISHED BY THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY

JUNE 1950

THE FUTURE OF YOUR PRODUCT IS IN THESE HANDS

wet-strengthen your paper with the UFORMITE resins

Who gets the blame when your customers' customers complain about paper bags that burst when wet? And who loses business?

The cheapest and simplest way to make better paper, and to safeguard and widen your markets, is to wet-strengthen your paper *now* with the UFORMITE resins. The cost is low—only $4 per ton of paper. Results may astonish you—wet Mullen values up 300%, dry Mullen and fold values increased 10% to 30%, better wet rub and scuff resistance, and wet and dry tensile. All without pretreatment, special equipment or special processing.

Full technical information on the UFORMITE resins for wet-strength is yours for the asking. If you make bags, towels, reproduction or printing papers, glassine, grease-proof wrappings, or twisting tissues, get the facts today.

OTHER CHEMICALS FOR THE PAPER INDUSTRY

RHOZYMES BB and E-5—for enzyme conversion of starch.

TAMOL N—for effective pitch control—a dispersing agent for pigments.

TRITONS—Surface-active agents with a score of uses in paper manufacture—defoaming, absorbency control, in caustic cooking of cotton fiber, as a dispersing agent for pigments and metallic soaps, emulsion-type coatings.

The Hydrosulfites—Reducing agents for stripping color from rag stock or for bleaching pulp.

HYAMINES—Deodorants for paperboard and glue bactericides.

UFORMITE, RHOZYME, TAMOL, TRITON, HYAMINE *are trademarks, Reg. U.S. Pat. Off. and in principal foreign countries*

CHEMICALS FOR INDUSTRY

ROHM & HAAS COMPANY

THE RESINOUS PRODUCTS DIVISION

Washington Square Philadelphia 5, Pa.

The Resinous Products Division was formerly The Resinous Products & Chemical Company

DU PONT PIGMENT COLORS *for*

WALL PAPER
COATED PAPER
FLINTED PAPERS
BEATER DYEING

STANDARDIZED PIGMENTS to MEET the EXACTING REQUIREMENTS for PAPER COLORING

THE DU PONT LINE includes economical pigments of highest quality. There are colors for beater dyeing which have been especially processed for quick and thorough dispersion in water. They have better strength than the usual lakes for beater coloring. Use them for papers which must have good lightfastness.

All these Du Pont pigments are standardized for properties important to their use in paper. They may be adapted to the most exacting requirements.

You can get further information from your Du Pont salesman, or by writing to E. I. du Pont de Nemours & Co. (Inc.), Pigments Department, 1007 Market Street, Wilmington 98, Delaware.

DU PONT PIGMENTS for QUALITY PRODUCTION

Chrome Yellow ☆ Organic Yellow Lakes ☆ Soluble Blue
Pigment Green B—full strength and lakes ☆ Molybdate Orange
Dispersible "Monastral" Blue and Green Lakes ☆ Toluidine Red
Watchung Red ☆ PTMA—Blue, Green and Red Lakes

● Tune in to Du Pont "Cavalcade of America," Tuesday Nights—NBC coast to coast

DU PONT
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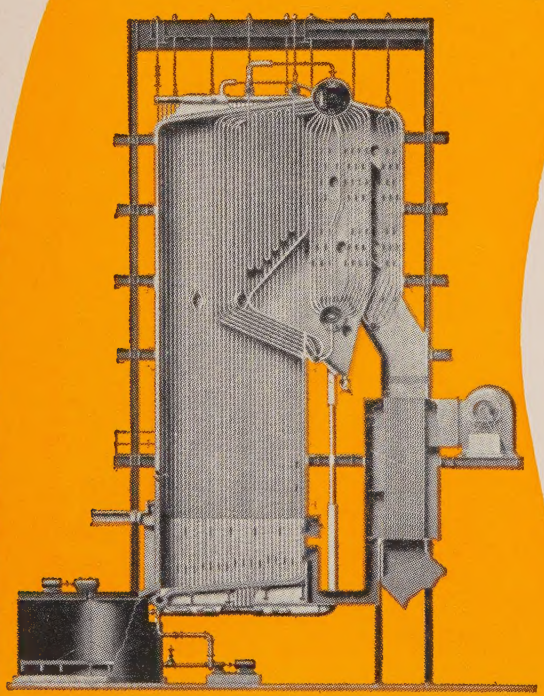
BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

DU PONT PIGMENTS FOR PAPERS

SELECTED FOR PALATKA

.....another B&W Recovery Unit



Typical B&W Two-Drum Black Liquor Recovery Unit.

A product of B&W Engineering for economy

For its sulphate mill at Palatka, Florida (shown above) the Hudson Pulp & Paper Co. recently ordered a 250-ton B&W Recovery Unit. An existing 160-ton B&W Unit has been in service since Nov. 1947 at this mill. This repeat order for a larger unit of the same design tells its own story.

The new unit will handle 1,500,000 lb. of black liquor daily, and will generate 112,900 lb. of steam per hr. at 450 psi and 725 F.

Repeat orders are an old story with B&W Recovery Units. High chemical and heat-recovery, high availability, low-cost operation, and maintenance simplicity due to elimination of hand lancing, account for their industry-wide preference.

B&W BABCOCK & WILCOX

P-51

Etching, 1805, from the Bettmann Archive

"Take a Letter, Please!"

Centuries before the invention of shorthand and the typewriter, the public scribe was a familiar figure in the cities and villages of the Old World. He rendered a useful service, conducting business and family correspondence for those who could not write. Also, he could be counted on to have a few sheets of precious paper. In those days paper was scarce the world over, for it was all handmade. The miracle of modern paper making lay far in the future.

Today, writing and duplicating machines and plentiful paper are the indispensable tools of business—providing the most widely-used and most essential means of communication. And fine papeteries supply the most discriminating demands of social correspondence. Stationery is now a fifty-million-dollar annual business. Production and packaging of writing paper in its various forms constitute an important part of the great American pulp and paper industry.

The dramatic story of paper is told in the sound-and-color film, "Paper — Pacemaker of Progress," and in a book under the same title. Both are presented by F. C. Huyck & Sons as a tribute to the Paper Industry. The book will be sent free upon request.

F. C. HUYCK & SONS • *Kenwood Mills* • RENSSELAER, N. Y.

KENWOOD WOOL PRODUCTS

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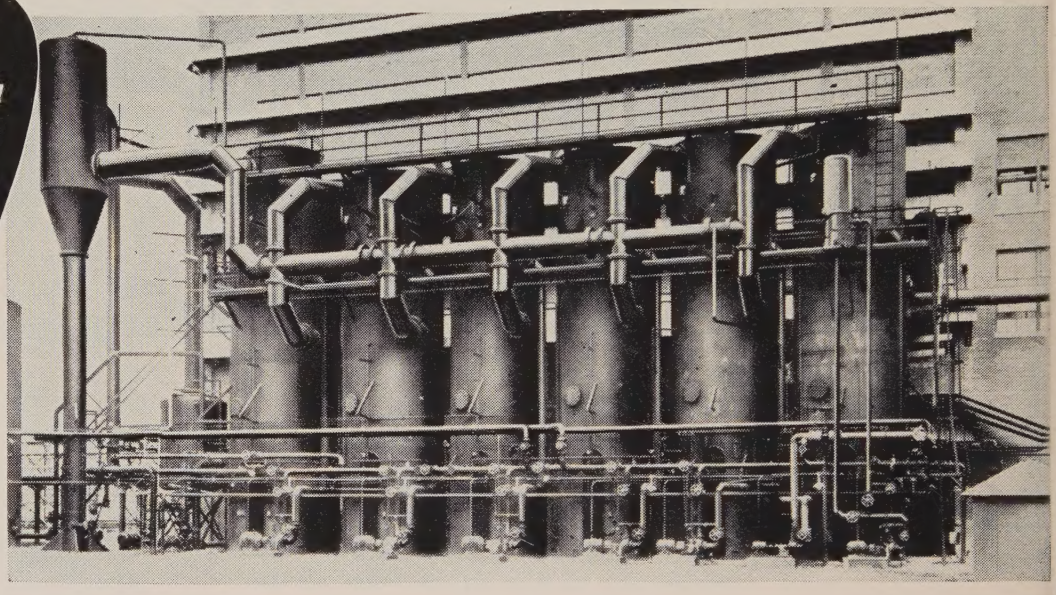
See General American for

CREATIVE EVAPORATOR ENGINEERING

Installed outdoors or indoors . . . the new Conkey Integral Evaporator cuts overall evaporating costs

Designed to do your job best!



Conkey Integral Sextuple Effect Evaporator outdoor installation at southern pulp mill.

It's Self-Supporting—in more ways than one! Savings start the day the new Conkey Integral Evaporator comes into your plant. Unit is shipped fully assembled. A single up-ending operation sets it in place. As a result, you save on assembly, parts handling and erection costs. In addition, there are important savings in floor and building space—since no external centrifugal type separators, outside flash tanks and piping are needed. Where weather conditions permit, the entire unit may be installed outdoors—with no housing needed except for pumps and instruments.

Operating advantages of Conkey design are noteworthy. Because it reduces pressure drop losses between effects, it provides an increased working temperature drop across the heating element surface. This means a net positive gain in evaporation—extra evaporating capacity.

Long life—Integral construction eliminates many flanged joints, assuring both durability and tightness. For complete information that may be useful to your firm, write today.

Other General American Equipment:

Turbo-Mixers, Filters,
Thickeners, Dewaterers, Dryers,
Towers, Tanks, Bins,
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JUNE 1950

Tappi

VOL. 33 · NO. 6

Published monthly by the Technical Association of the Pulp and Paper Industry

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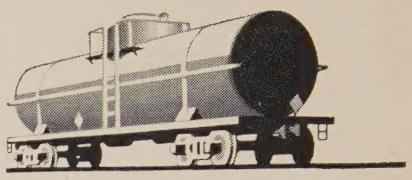
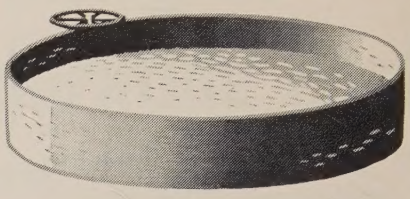
Published monthly by the Technical Association of the Pulp and Paper Industry at 20th and Northampton Streets, Easton, Pa. Editorial and advertising offices, 122 East 42nd Street, New York 17, N. Y. Articles for publication and communications regarding the editorial content of *Tappi* should be addressed to the Editor at the editorial office. Statements and opinions expressed in articles and editorials appearing in *Tappi* are those of the contributors, and the Technical Association of the Pulp and Paper Industry assumes no responsibility for them. Subscription: U. S. and possessions, $7.50; Canada, $8.25; Pan American Union, $9.00; Other Foreign, $10.00. Single copies to members of TAPPI, $0.75; Nonmembers, $1.00. Entered as second class matter January 27, 1949, at the Post Office at Easton, Pa., under the act of August 24, 1912. Copyright, 1950, by the Technical Association of the Pulp and Paper Industry. An index of the technical articles appearing in the magazine appears in the Industrial Arts Index and the Engineering Index.

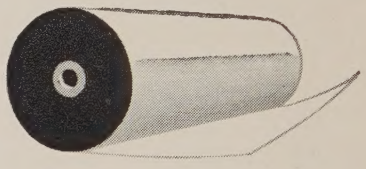
soda bleach savings with Wyandotte liquid caustic soda



1 Handling costs are reduced because less labor is required in unloading, storing and using *liquid* caustic.



2 Soda bleach foams less in the washers than other bleaching chemicals. Pulp draining and drying are faster, more economical.



3 Soda bleach made with Wyandotte Caustic Soda insures a cleaner finished paper with a minimum reversion of brightness.

These are some of the money-saving advantages Wyandotte Liquid Caustic Soda provides in the bleaching of wood, rag, straw and waste paper pulps.

Wyandotte's skilled Technical Service staff will be glad to help you search out economies in bleaching and other operations, as they concern your particular requirements. For information, simply contact your nearest Wyandotte Representative, or write direct to:

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SODA ASH • CAUSTIC SODA
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OTHER ORGANIC AND INORGANIC CHEMICALS

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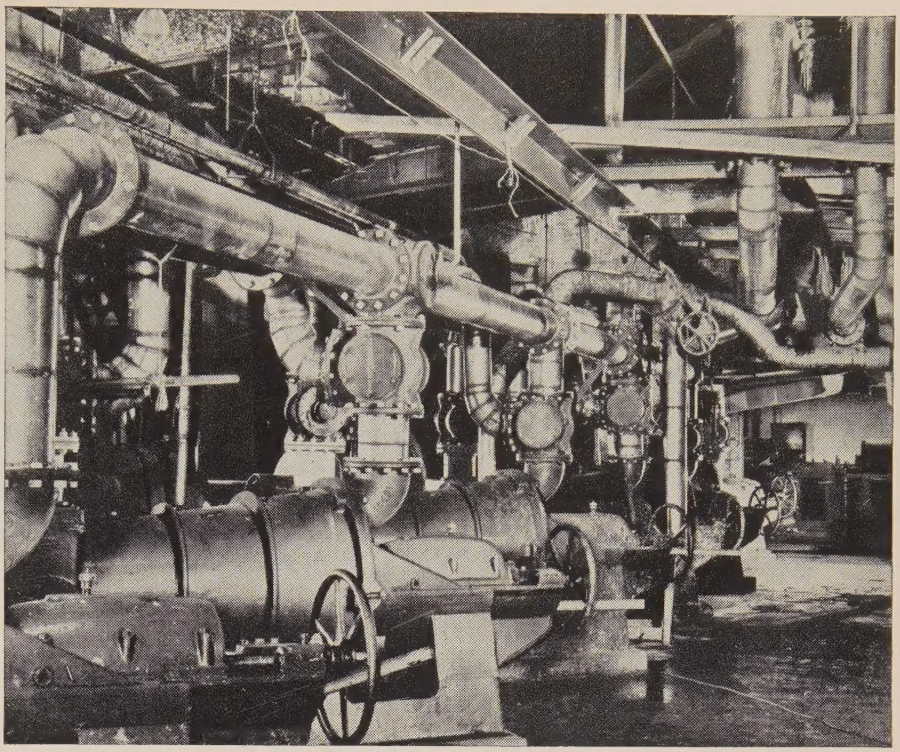


A Monel stock line installation at the River Raisin Paper Company, Monroe, Mich. These fabricated Monel stock lines run from jordan engines to rear of solid Monel headbox on a board machine. Fabricated by BROWN-HUTCHINSON IRON WORKS, Detroit, Mich.

How do you keep YOUR STOCK LINES from Sliming?

Keeping slime and fibre accumulations from forming in stock lines can be expensive . . . but many leading mills have proved that it need not be.

The simple fact is—*stock lines and fittings* made of "35" Monel® will not promote fibre accumulations or slime.

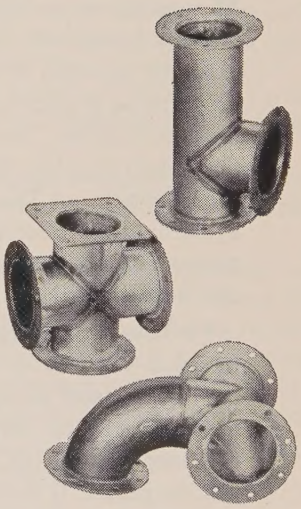
The secret of Monel's outstanding performance in stock lines is a twofold one. "35" Monel, in the experience of many mills, provides the most *wettable* surface of *any* commonly-used metal stockline material. And Monel retains this surface because it is 100% rustproof as well as highly resistant to paper-making chemicals.

Monel is readily workable . . . easy to form . . . easy to braze, weld, or solder . . . stays ductile without further heat-treatment.

Still other advantages . . . Monel stock lines are lighter in weight, easier to install and relocate with a minimum of labor. Monel's extra strength and stiffness permits using thin-walled sections that weigh much less than most conventional units.

In addition to stock lines, Monel has an excellent performance record in many other important paper-making applications . . . stock inlets, slice blades, head boxes, jordan fillings, doctor blades, screen plates, winding wire, pump shafts, valves, piping.

Take the first step towards lower maintenance costs in your plant by writing today for further information about money-saving Monel stock lines and fittings.



Fabricated Monel Elbows and Tees, used with Monel stock lines. Fabricated by BROWN-HUTCHINSON IRON WORKS, Detroit, Mich.

THE INTERNATIONAL NICKEL COMPANY, INC.

67 Wall Street, New York 5, N. Y.

EMBLEM OF SERVICE INCO TRADE MARK

MONEL ...FOR MINIMUM MAINTENANCE

How to beat a legal "threat" on WASTE DISPOSAL

. . . and cut fibre and chemical losses!

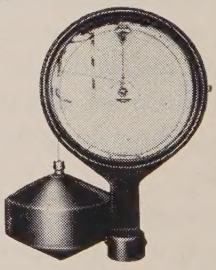
WITH STATE AFTER STATE now imposing legal restrictions on industrial waste disposal, you may be faced with this problem quite suddenly. Only by starting to gather complete data now can you be prepared for necessary action when that time comes. And the same data will reveal the extent of your fibre and chemical losses in plant waste. (The Foxboro waste-sampling system gives a continuous sample always in proportion to effluent rate—thereby assuring an accurate analysis.)

Foxboro has prepared a concise, informative bulletin on how to conduct a waste disposal survey. Based on specialized knowledge and long experience, this bulletin outlines the simple steps you can take to avoid hasty, last-minute plans. It shows how a careful, unhurried survey now can easily provide the facts on day-to-day quantities, concentrations, and constituents, so essential to efficient planning.

Send for a copy of "Waste Disposal Surveys". Write The Foxboro Company, 78 Neponset Ave., Foxboro, Mass., U. S. A.

TYPICAL FOXBORO INSTRUMENTS THAT LEAD TO BETTER WASTE DISPOSAL

The Model 40 . . . "The finest modern controller" . . . is the foundation of many outstanding Foxboro Waste Disposal Systems. It is used for the control of flow, pH, conductivity, temperature and other variables. Thousands are in use daily.



Foxboro Float and Cable Type Instruments are specifically designed for use on weirs and Parshall flumes. They read directly in *flow*.

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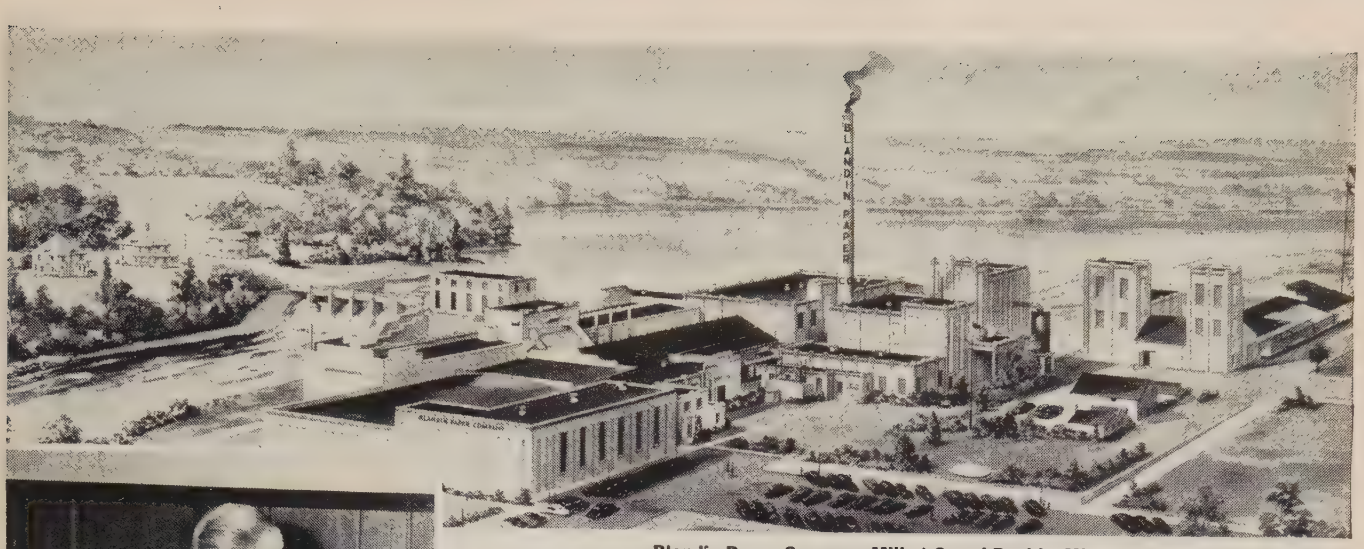
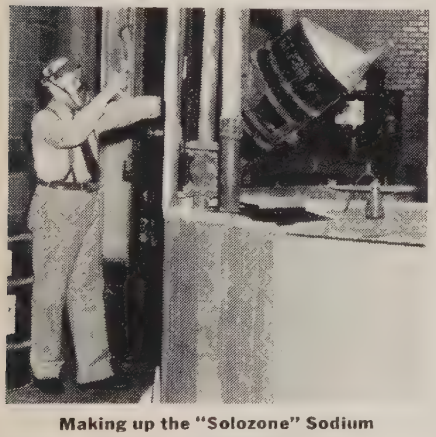


Blandin Paper Company Mill at Grand Rapids, Minnesota.

Mr. C. K. Andrews, General Manager, Blandin Paper Company.



Making up the "Solozone" Sodium Peroxide bleaching solution.

Blandin reports increased brightness, lower cost, trouble-free operation WITH THE DU PONT PEROXIDE PROCESS FOR GROUNDWOOD BLEACHING

Originally a newsprint mill, the Blandin Paper Company now manufactures only groundwood printing papers largely used in magazine publishing.

Mr. C. K. Andrews, General Manager of Blandin, says:

"Since March 1948, we have been peroxide bleaching groundwood with very good results. Average brightness has increased 9 points, somewhat better than predicted. Use of bleached groundwood in our paper furnish has improved the opacity.

"We operate at about 15% of consistency. At this consistency we believe we receive higher brightness and faster bleaching, using less chemicals than at lower consistency, and have trouble-free operation.

"Advantages of this system are simplicity of operation, elimination of washing of the product. It appears more practical on groundwood pulp than other methods of bleaching."

Furthermore, Blandin has found that the yields obtained in this process are between 98 and 100% . . . that although bleaching groundwood does not eliminate fading, it does retard it . . . and that the reaction to bleached groundwood in their grades, from the printing industry, is favorable, due to the improvement in color and cleanliness.

Tune in to Du Pont "CAVALCADE OF AMERICA"
Tuesday Nights—NBC coast to coast

Experience has shown that peroxide bleaching is not limited to groundwood. It can be adapted to soda, sulfite, semi-chemical, and kraft pulps and for waste-paper recovery. Technical service and assistance in specific applications are available upon request. For more information about Du Pont peroxides and the Du Pont bleaching process, just fill in and mail the coupon below.

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PEROXIDES
FOR GROUNDWOOD BLEACHING

AVAILABLE IN DRUMS AND TANK CARS
- **"Albone" 35 . . . . . Hydrogen Peroxide, 35%**
- **"Albone" 50 . . . . . Hydrogen Peroxide, 50%**
- **"Solozone" . . . . . Sodium Peroxide**

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E. I. du Pont de Nemours & Co. (Inc.)
Electrochemicals Dept., Wilmington 98, Delaware

Please send me further information about Du Pont peroxide bleaching processes: (check application)

____Groundwood ____Sulfite ____Soda Pulp ____Kraft

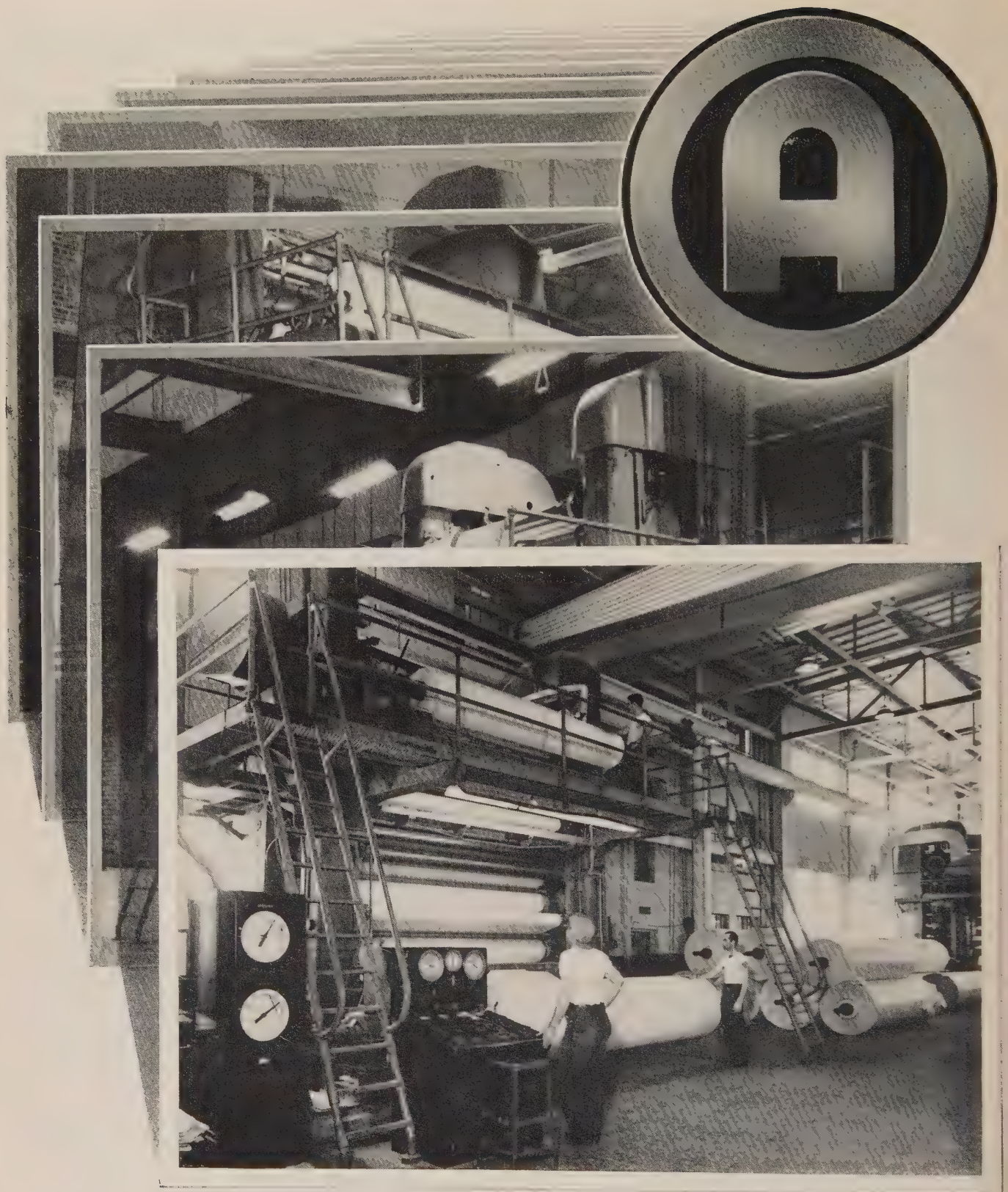
____Semi-chemical pulps ____Waste-paper recovery

*Name*_____

*Position*_____

*Firm*_____

*Address*_____



The intimate knowledge of finishing-room problems gained through the close cooperation of Appleton engineers and mill technicians in achieving finer finishing on papers is reflected in Appleton Super Calenders with their many advancements and refinements for better performance and precision controls at high speeds . . and in the complete selection of Appleton Filled Rolls, many developed for new or special supering needs. THE APPLETON MACHINE COMPANY ● Appleton ● Wisconsin

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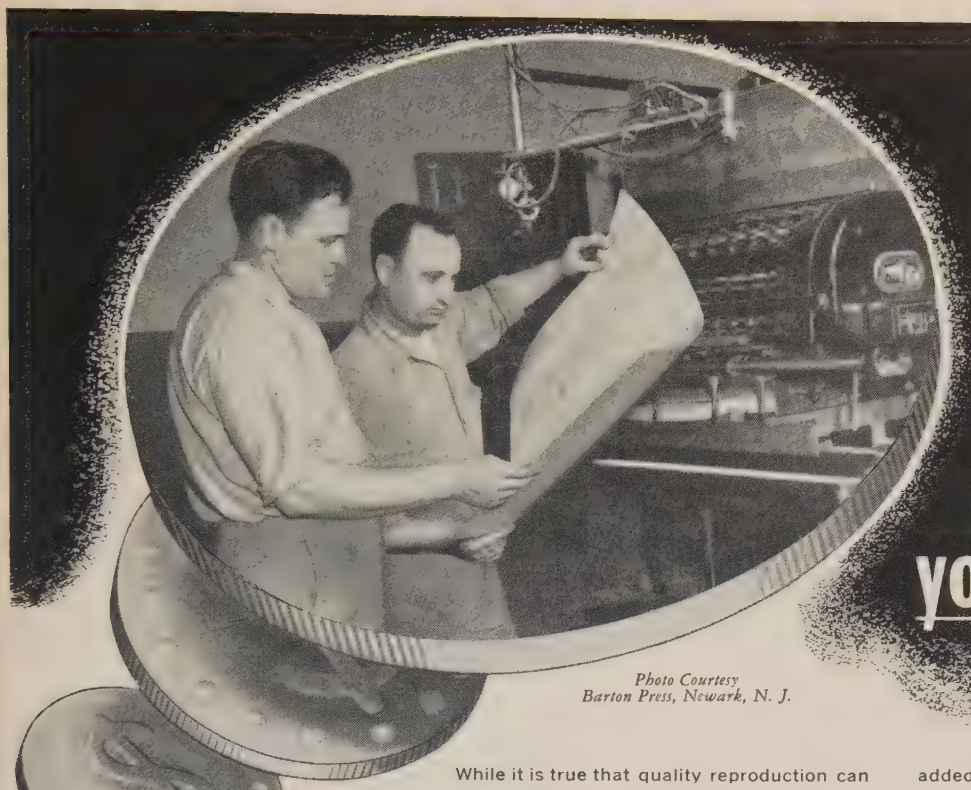


Make Sure your Coatings Protect your Profits

Photo Courtesy
Barton Press, Newark, N. J.

While it is true that quality reproduction can only be achieved when paper, ink and press conditions are compatible, paper is the dominant factor—and paper coating can largely determine results.

Sub-standard coating, therefore, is a sure way to customer dissatisfaction—and profitless operation for you.

Nopco* offers a number of products that have been specially developed to eliminate coating defects such as pinholes, fish eyes, uneven pigment distribution and dusting. These outstanding chemicals enable you consistently to obtain a finished sheet that insures ready consumer acceptance, wins repeat business, builds sales. Examples are:

NOPCO ESI—for control of foam in coating compositions. Improves flow and brushing characteristics when used with starch, casein or other adhesives. Enhances brightness and gloss. Gives uniform smoothness to final coating. Reduces dusting on the supercalender. Improves fold—minimizes cracking and flaking. Available in 55-gallon drums.

NOPCO 1497-B—for use as a defoamer in coating compositions which employ casein or other proteins as binder or adhesive. If added to adhesive after it has been solubilized by alkali, but before clay and color are added, Nopco 1497-B inhibits foam formation. If diluted with water and added to coating mix on coating machine, this Nopco product proves an effective foam killer. Available in 425-lb. barrels.

NOPCO 1600-B — for all general defoaming and leveling requirements. Works well with colored coatings. Nopco's strict system of manufacturing checks and controls assures absolute uniformity. Available in 55-gallon drums.

NOPCO 1400-B—for addition to paper machine coating when starch adhesive is used. Imparts water repellency. Prevents dusting—thereby reducing need for frequent washing of calender rolls. Available in 425-lb. barrels.

NOPCO SOAP-R—for plasticizing or lubricating the coating color. A high quality, low titre soap. Available in 80-lb. multiwall bags and 150-lb. barrels.

Full information about these products, and other Nopco paper chemicals for use in all phases of paper and paper board manufacture, is yours for the asking. In addition, our Technical Service Department is ready at all times to help you solve your production problems. Profit by writing us today.

*Reg. U. S. Pat. Off.

NOPCO CHEMICAL COMPANY, Harrison, N. J.

Gentlemen:
Please send me full information about the Nopco Paper Chemicals checked below.

Nopco ESI ☐ Nopco 1497-B ☐ Nopco 1600-B ☐
Nopco 1400-B ☐ Nopco Soap-R ☐ Please have your representative call ☐

Name.....
Firm.....
Address.....
City.....Zone.....State.....

NOPCO
TRADEMARK
EVOLVED THRU RESEARCH

NOPCO CHEMICAL COMPANY

Formerly National Oil Products Company
HARRISON, NEW JERSEY
Branches: Boston, Chicago, Cedartown, Ga., Richmond, Calif.

A CONTINENT-WIDE SERVICE

representing 278 years of experience

The thirteen men whose photos and service records appear on this page are well known to pulp and paper mill operators from coast to coast and gulf to gulf as field supervisors for STEBBINS.

Their years of experience in this specialized field of corrosion-resistant linings and tile tank construction assures each mill operator long lasting, trouble-free service from any one of the many STEBBINS' installations, whether it be in the acid plant, digester building, bleach plant, or paper mill.

We are proud of the service records and loyalty of these men and the 92 experienced craftsmen comprising our field organization across the continent. They in turn are proud of STEBBINS' reputation for quality materials and quality workmanship on all of their installations.

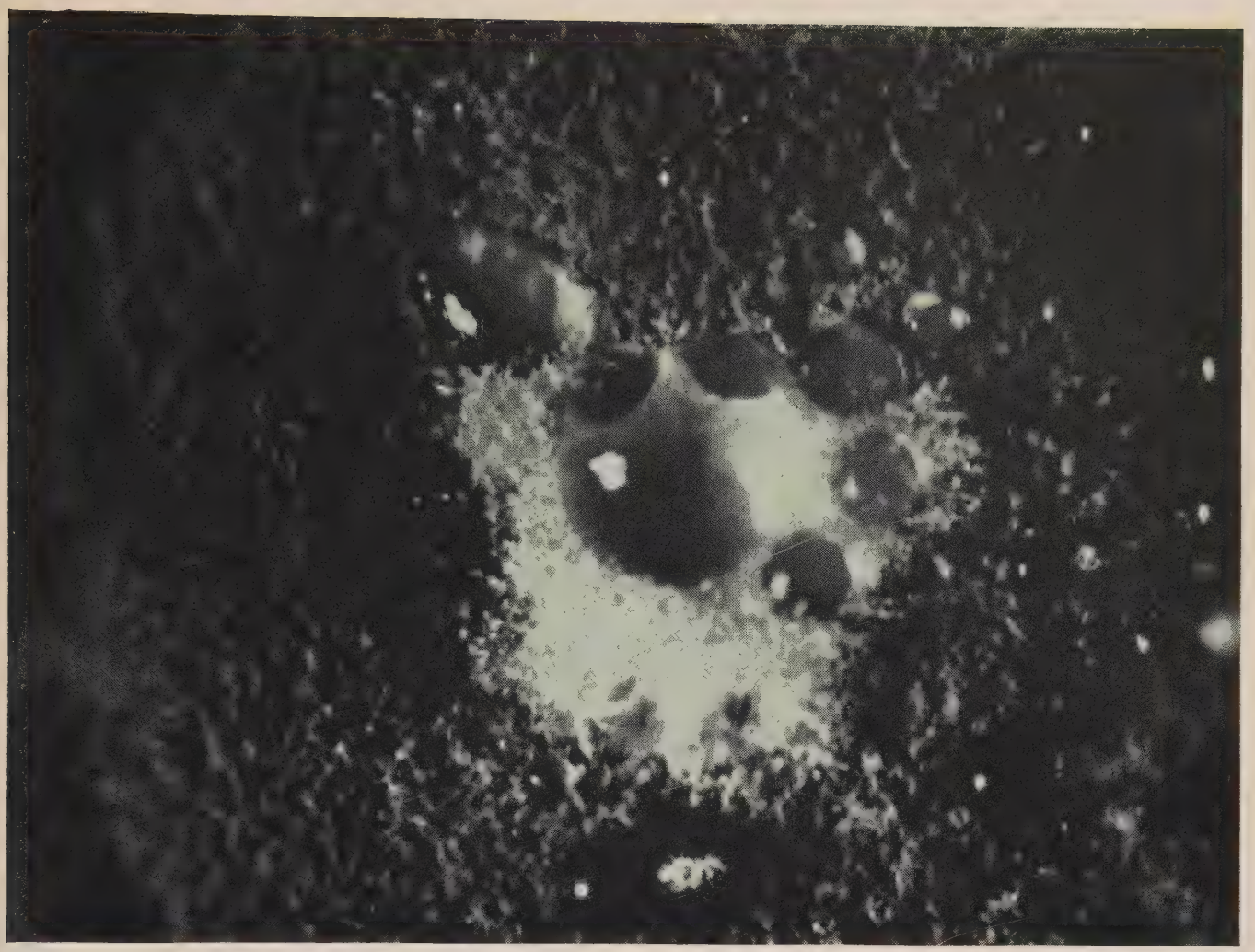
SEMCO

Stebbins Engineering and Manufacturing Company

WATERTOWN, NEW YORK

CANADIAN STEBBINS ENG. & MFG. CO., LTD. – CASTLE BLDG., MONTREAL, CANADA

STEBBINS ENGINEERING CORP. – TEXTILE TOWER, SEATTLE, WASH.



Aspergillus from growth on paper magnified 78X.

Beat the "Bugs" to the Draw!

Now you can ward off costly attacks of bacteria and mold *before* these microorganisms become numerous enough to cause production losses and wasted materials. You can keep them out of lap stock and prevent discoloration and loss of pulp which they often cause.

Like many leading paper mills, you'll gain proper microbial and mold control with Dowicides, Dow's industrial germicides and fungicides. Dowicides will bring protection against bacteria and mold.

Beat the "bugs" to the draw! Investigate Dowicides today. Complete laboratory facilities are maintained by Dow to help solve your problems. Contact your nearest sales office or write direct.

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The Retailer Looks at Packaging

THE retail business man is becoming increasingly aware of the important function of packaging in selling merchandise. For this reason it seemed appropriate for field representatives of the Department of Commerce to conduct a nation-wide sampling of opinion at the retail level of the adequacies and inadequacies of present-day packing. Many of the suggestions made in this sampling of opinion are not new, but some of them have been included in this report even though they are a reiteration of generally known packaging deficiencies. These suggestions have been restated herein because, quite apparently, not enough definitive action has been taken, at least in the sense of universal application. Retailers interviewed included those engaged in the food, drug, department store, and hardware businesses.

The consensus of retailers is that packaging fabricators in the main are keeping abreast of the rapidly changing merchandising methods, but the art of merchandising is never static. Consequently, to successfully market merchandise under highly competitive conditions, long-established, old-line producers, as well as newcomers, have introduced innovations in the size, shape, color, and material of packages and containers. The advent of super markets and self-service retail establishments has given added impetus to the use of attractively designed, functionally acceptable containers and packages that will attract the public and increase sales.

Present-day packaging methods and techniques were commended by the majority of retailers; they asserted that prepackaged merchandise received by them, with exceptions, was neither under nor over packaged, but that the packages and containers used were usually adequate for the job. They indicated, however, that although manufacturers and suppliers are doing a good job and are in keeping with the merchandising trends, there is room for considerable improvement in the packaging field.

INADEQUATE PACKAGING

Retail grocers in the Detroit area, commented that the merchandise received was usually adequately packaged and that comparatively little damage occurred in transit. These grocers further observed, however, that most damage occurred to merchandise enroute to the retailer, as a result of either faulty or careless packaging, or using inadequate packaging materials and methods.

A retail department store executive in Richmond, Va., indicated that manufacturers and suppliers of fragile items such as china, glassware, furniture, and lamps should employ extra precautions in packaging these types of products. Occasionally damage to merchandise is not known by the retailer upon receipt because the exterior of the container has not been ruptured and the damage detected until the merchandise is unpacked either in the store or in the home. Such merchandise shipped in the original container, from retailer to the consumer without inspection, has been a cause of considerable adverse comment and publicity. This retailer indicated that not only should extremely careful internal packaging techniques be applied, but also the contents of the package should be noted by the increased use of such labels as, "fragile," "glassware," "handle with care," etc.

Another example of damage occuring in transit as the result of inadequate packaging was cited by a retail grocer in San Francisco. He pointed out that prepacking such items as dried fruits, beans, and similar items in some films resulted in an excessive amount of breakage during long freight or truck hauls. The inadequacy of merchandise packaging by manufacturers or suppliers was noted by one department store manager who complained particularly about the flimsy materials used in packaging toys. One retailer, selling imported merchandise, complained vehemently about poorly, very inadequately packaged merchandise which he received. He indicated that the containers, usually packaging fragile items, did not provide protection and resulted in an extremely high percentage of loss due to breakage.

Comments were offered on the damage which occurred to merchandise, after it is received by the retailer, as a result of overpackaging by the supplier. One grocer indicated that, in many instances, the unpacking of products by inexperienced employees often inflicts damage to otherwise undamaged items. One suggestion offered by a retailer to prevent merchandise from being damaged in the unpacking process was the placing of explicit instructions for opening the packages on the outside of the shipping container. Another retailer cited similar experiences in opening tightly sealed packages which caused damage to previously undamaged merchandise. He indicated that many firmly sealed containers and packages now in use require an excessive amount of costly man-hours to open and often result in damage not only to the contents but also to the employee's hands. One druggist, exasperated by previous encounters with tightly sealed packages, stated it was often necessary for him to stand on top of the container and disect it piece by piece. He suggested that shipping packages and containers be sealed by gum paper that could easily be slit or cut with a knife or razor blade.

This damage to merchandise, either occurring in transit or after being received, is very costly to the retailer. Eventually, these added costs are paid by the consumer in the form of higher retail prices, and such increases in prices create consumer buying resistance. Conversely, a reduction in retailing cost through decreasing the amount of damage to merchandise will be reflected in reduced selling price. It is felt that any additional expense involved by added labor, time, and material in more careful or adequate packaging will be more than offset by the increased volume of sales by speeding up the time required to get the merchandise on the sales floor.

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Several methods were suggested to reduce retailing costs and expedite the moving of merchandise from receiving departments to the shelves, counters, and other display areas. One retailer indicated that information such as invoice numbers, purchase order numbers, store department numbers, etc., should be plainly indicated on the package. A grocer suggested that manufacturers and suppliers could facilitate the marking, handling, and moving of merchandise to the floor by packing all merchandise right side up in shipping containers rather than in an unsystematic manner. He also suggested that the top of the shipping package should be plainly marked to eliminate unnecessary handling prior to unpacking.

An additional feature was suggested by a retail clothier who requested that the manufacturer or supplier tightly secure clothing in shipping containers in order to eliminate the need for pressing, etc., before displaying them. An executive of a large retail mail-order business indicated that although present day shipping containers were much lighter, many are still too heavy. He proposed the development of durable lightweight packaging materials to offset added expenses resulting from an increase in postal rates.

Other suggestions and recommendations to increase the degree of merchandise protection are: (1) develop a light, cheap, and disposable substitute for the bulky, messy, shredded newspaper or excelsior protection material now in use; (2) increase merchandise protection by use of shipping containers reinforced with inside partitions and adequate dunnage.

PREPACKAGING

Another aspect of packaging, as it appears to the retailer, revolves around the problem of the sale of bulk vs. prepackaged merchandise. The trend of the food industry from the local grocer to the giant self-service super market has increased the use of prepackaged merchandise. Whether this packaging has been done by the supplier or by the retailer, the increased use of prepacked products has almost always stimulated sales as well as resulted in a decrease in expensive labor costs to the retailer. Retailers in all types of businesses and almost without exception are reported to be on the alert for new methods or developments which will result in a decrease of such costs. Grocers indicate that prepackaging reduces the weigh-in time involved in bulk selling. Prepackaging not only reduces the time involved in consummating the sale, but quickens the check-out time at the cashier point. This prepackaging preference is not alone confined to the food industry but is found in other retail businesses. A department store manager indicated that he believed prepackaging of merchandise is a money-saving device because it decreases the time element and the physical handling necessary to move merchandise from the receiving department to the sales floor.

Retailers expressed the opinion that prepackaging is primarily a supplier's function. One grocer indicated that, due to consumers' acceptance and preference of prepackaged merchandise and because it is a sales stimuli, he was going to "package everything" usually sold from bulk stock. This same feeling was expressed by a West Coast food retailer when he indicated that if prepackaging was not done by the supplier, it would have to be done in the retail establishment. This trend is noticeable in the increased amount of meats, cheeses, etc., that are being packaged by individual retailers.

Prepackaging-conscious retailers suggested that suppliers become time conscious in the ways of retailers in order to save the costs involved in unpacking, repackaging, marking as to size, price, etc., and shelf-stacking methods which are necessary in the handling of bulk merchandise. Displays commodity in original manufacturer's package, facilitates stacking, expedites delivery, and brings merchandise nearer the customer are advantages of prepackaged merchandise.

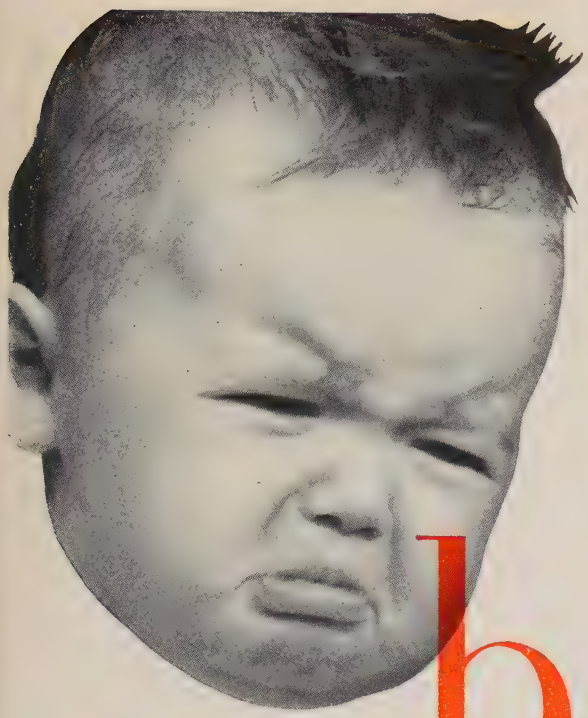
Further advantages are that prepackaging minimizes loss in handling, displays more merchandise per square foot, consumes less warehouse space, reduces damages by climatic conditions, performs task of silent salesman, and permits ease of wrapping packaged goods as opposed to unpackaged goods. These are the characteristics the Department of Commerce field representatives found to be eagerly sought by store buyers in selecting goods to be purchased.

CONTAINER DESIGN

The sizes and shapes of packages and containers were discussed in detail by practically all retailers interviewed in this special survey. The popular containers are those which lend themselves to utilizing maximum shelving and storage space, stack easily without fear of falling over, i.e., have "stackability," and are of a convenient small family size so that the customer will receive optimum utility of the contents. While improvements that will add to the "eye-appeal" of a package or a container are encouraged, such improvements are not advocated at the expense of its functional quality. One department store executive indicated that his store did not renew orders with suppliers who neglected the functional quality of a package for "eye-appeal."

One retail grocer in Kansas City, Mo., suggested using a rectangular container rather than a round one for merchandise having fast turnover. This change, he indicated, would provide more packages per square foot of shelf space and thereby reduce the number of trips to the store room to replenish the often-depleted display stock. Small, narrow packages which lack stability and are constantly tumbling over, thereby requiring additional effort to prevent disorderly display, and larger over-sized packages which consume extra shelf space, could both be eliminated, in the opinion of many retailers. Furthermore, retailers expressed dislike for packages and containers which do not safely stack on shelves, such as dome-shaped and other odd shaped containers. These irregular shaped containers are also difficult to wrap as gifts. One retailer stated that, "odd shaped containers are a bane to their existence." Another indicated that packages that "stack best, sell best." On the other hand, some retailers say that the attachment of novelties, such as whistles, toys, etc., to packages, although difficult to handle and display, are excellent sales producers.

There appears to be an increasing demand for smaller containers because of the decrease in the size of families and the limited amount of storage space in small homes and newer apartments. Smaller containers are reported to tend to reduce the amount of product waste



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to the consumer. Consequently, there is often sales resistance to the larger sized containers. One druggist offered the suggestion that the size of the standard medicine cabinet and shelves be considered as an important factor in designing packaging for toilet articles, proprietary drugs, and prescriptions. The opinion was expressed that slow moving merchandise would sell more rapidly if packed in smaller quantities providing any increase in the retail price was nominal. A suggestion to fill the containers more fully was offered as a means of reducing the size of packages now in use; for example, it was noted that some soap and cereal containers are not fully utilized. While it is recognized that smaller containers are more desirable for certain types of merchandise, it is also admitted that the large-economy size package is very popular in many instances and an excellent selling device.

Further standardization of packages and containers is necessary, it was indicated by one retail grocer. He pointed out one example where four different size containers contained practically the same volume; here, he indicated, was a need for container standardization. This retailer, along with others, further stated that there are ten different size packages for dry fruits and vegetables. He suggested revision of packages and containers that could reduce the excessive number of packages to three sizes: small, medium, and large. Packaging standardizations would eliminate very small and extremely large sizes and, hence, reduce the worries retailers have in complete utilization of expensive display space.

From the retailer's viewpoint, packaging is well on the way to being successful if it helps stimulate sales. Retailers want items packaged so attractively that they not only sell the customers in the store but will also sell them again when the packages are opened at home. Retailers are concerned with consumers' satisfaction in the merchandise. Packages should not over-shadow contents, i.e., as to price, size, etc. The respondents disliked overpackaging that adds great expense to the retail price of the merchandise and particularly when the cost of the packaging, as in so many instances, exceeds the value of the contents. It was stated that fancy, elaborate packages and containers not only raised the retail price of the article, but it also increased sales resistance. A retail druggist stated that such increases in the retail sales price have effectively removed many goods from the lower income group market. Many retailers have refused to market items where the cost of the packaging exceeds the value of the contents. As a result of elaborate packaging, many $^1/_2$ and 1 pound boxes of candy have disappeared from candy counters.

The smaller the percentage of cost of product that is devoted to packaging, the better for the retailer through increased sales and because more units can be purchased with a given number of dollars. While it is recognized that packaging should bestow dignity and eminence on the merchandise, particularly gift type merchandise, such packaging is not acceptable if it results in increased buying resistance. Overpackaging that affected the retail price became such a problem in one large department store that the store specified the types of containers and packages to be used by their suppliers. Retailers are advocating that a maximum amount of packaging be provided at a minimum expense to the customers. On the other hand, overpackaging luxury items was favorably mentioned, if such is not excessive.

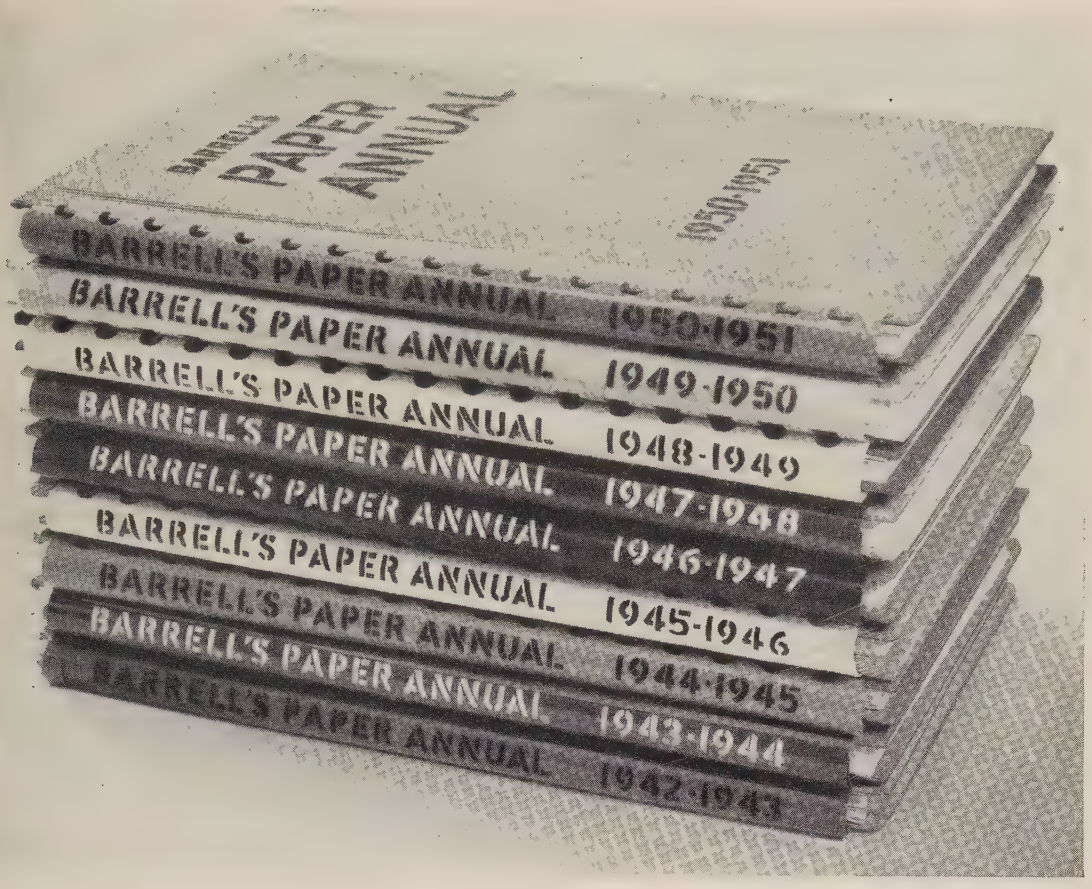
VISIBLE WRAPS

Visible wrapping has been successfully adapted for use in the protection of merchandise in clothing and department stores. Sheets, hosiery, sweaters, pajamas, etc., have been enclosed in plastic packaging to guard against merchandise soiling as a result of "fingering" by customers. Plastic coverings on books have prevented soiling; also, plastic containers have been used successfully to maintain in a satisfactory condition metal products which are subject to oxidation. Visible packaging has excellent customer's acceptance because contents are visible and reassures the prospective buyer that clean, fresh merchandise will be obtained. When merchandise such as clothing, jewelry, and household items are packaged in film, an unpackaged item should be available for close inspection by "feeling" as well as "looking." This selling technique has stimulated sale for both the "name" and other brands of merchandise. Retailers encourage use of transparent film pouches or bags with a fold-over-end, or other methods of leaving a small opening in the package in order to facilitate merchandise inspection. A variety store indicated the advisability of packaging toys in transparent sheet cellophane due to the present day psychology of absolute cleanliness. Packaging of edibles such as candy, peanuts, and other confections has come about through customer preference for cleanliness, freshness, etc. Other food lines, especially, meat, cheese, and produce have followed.

PACKAGING PROTECTION

Druggists are very selective about the type of containers in which their merchandise is packaged. They indicated that salts, sulphur, and other powders packaged in materials other than glass or tin are considered inadequately packaged because the container does not offer sufficient protection against moisture, or other deteriorating elements, nor does such packaging provide the stability necessary for handling. Plastic, they felt, may not prevent the "hydroscopic" action which takes place in powders. Many druggists expressed particular concern about the cardboard cartons for individual bottles. They indicated that generally these cartons have flaps at both ends, neither of which is sealed, with the result that the bottle often falls from the container when either unpacking or when showing the merchandise to a prospective customer. One druggist indicated that climatic conditions is a factor to be considered in packaging such items as razor blades because in certain sections of the country there is a tendency for them to deteriorate through oxidation caused by humid climatic conditions.

Several grocers were also concerned about packaging protection afforded the merchandise they sold. They indicated the need for improvements in packages used for such items as sugar, flour, soap powder, and other dry items where they felt the containers were not substantial enough to avoid crushing or breaking. They further indicated that single-walled cellophane used in packaging cigars, candy and etc., must be carefully



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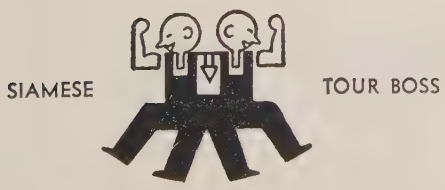

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watched for cracks and breaks which occur as a result of either excessive handling by the customer or employee, or from the increase and decrease of humidity and temperature that occurs in the store building. It was noted, also, that plastic windows often separate from the carton. Paperboard cartons for carrying out bottled soda are often inferior and break when carrying the package home. Waxed paper milk containers were the cause of some criticism because leakage from faulty cartons can cause damage to other grocery items or to a customers' clothing. It was generally agreed that better sealing methods are needed. One grocer expressed a need for more securely packaged bar soap to permit dumping in bins for bulk display.

Two different retailers indicated a need for improved packaging giving better protection to oily liquids and alcohols. Many present packages do not protect against leakage of oily liquids, where others do not prevent pilfering of such items as expensive perfumes and alcohols. A safe sealing device affording maximum protection of contents is necessary in order to assure the customer of obtaining the merchandise in the condition advertised. One large department store superintendent indicated a preference of tin for such items as cakes, cookies, and dried fruits because he felt that it afforded maximum protection of contents. He stated this was particularly true of imported bakery goods in order to prevent mold occurring in transit; he further indicated this type of protection was not as essential for domestic bakery goods.

Although packaging was recognized as being occasionally inadequate, it was remarked that such defects, when known, have been quickly corrected by the manufacturer. Most inadequacies resulted from the incorrect use of packaging materials. Complaints that certain prepackaged merchandise, sharp-edged candies, and other brittle items often tear packaging material such as single-walled cellophane. The practice of packaging oranges, lemons, and other heavy items in cellophane bags has resulted in an excessive amount of breakage. Doubled-wall cellophane has been reportedly used without much success because of the cast effect on candies, cookies, etc., making the contents appear stale and unappetizing. For example, a store experimented on consumer habit and appeal on a specific hard sugar candy using a display stand filled with double-wall cellophane containers one week and the same stand with single-wall cellophane the next week. The single-wall cellophane container sales were 300% higher although loss due to breakage was somewhat greater. The cast affect of double-walled cellophane is reported equally harmful to sales of textile items. These examples were cited by retailers as indicating the incorrect use of packaging materials.

When strength is not the primary requisite, packaging of such items as food and clothing in cellophane window cartons, potato chips, and certain candies in single-walled cellophane are a few examples of the proper selection of packaging materials to perform the function intended. One grocer indicated a customer preference for bulky grocery items such as oranges, grapefruit, potatoes, and apples in open-mesh bags. This packaging is not only strong enough to prevent breakage, but also gives the desirable appearance of graded merchandise. Another grievance registered by respondents is that some films imparted an odor or taste to the contents, also, a discoloration occurred to baking products and candies, particularly if some films come in contact with the contents.

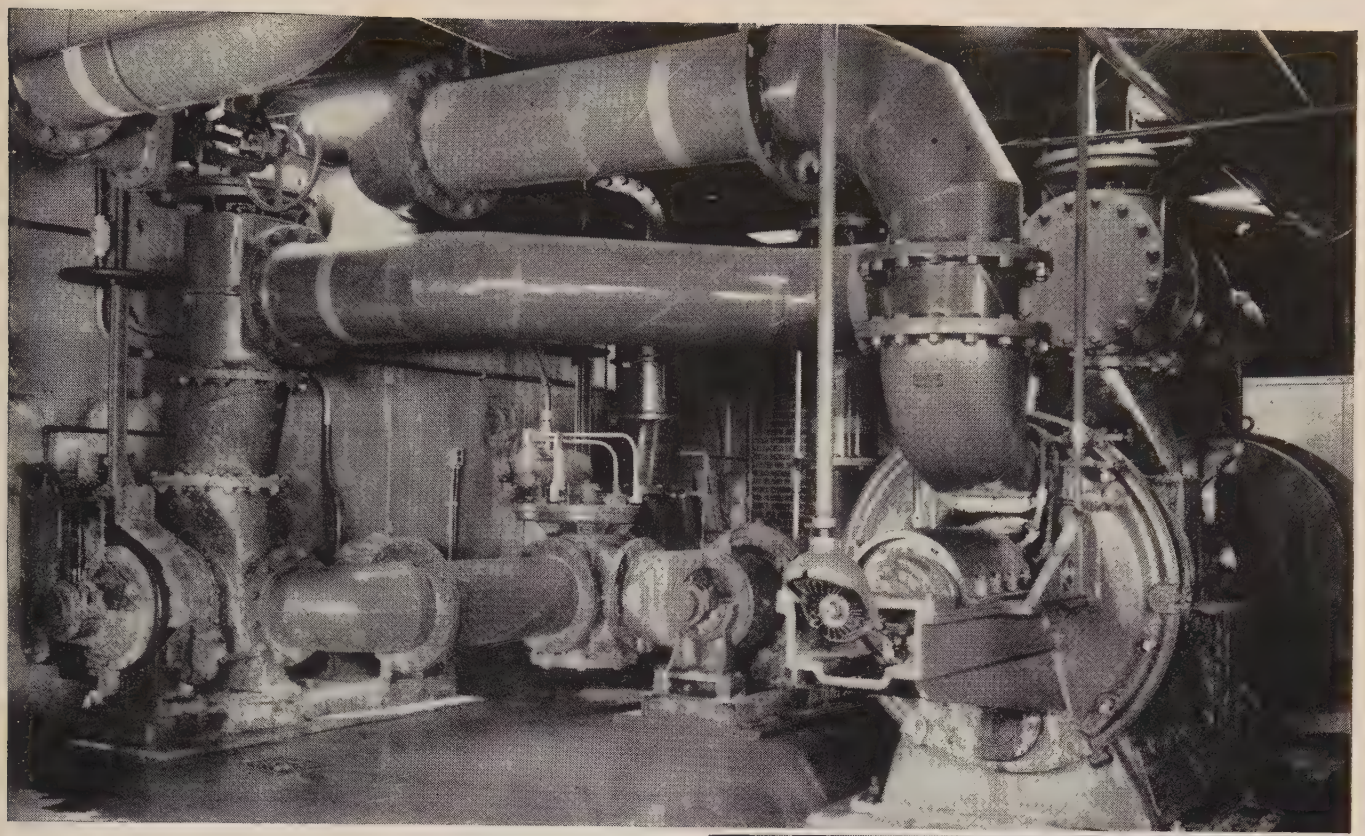
EYE APPEAL

Protection of the merchandise is a primary criterion of successful packaging; similarly, eye appeal is also an important factor to be considered in the designing of packages and containers. One retailer stated that "eye appeal is buy appeal" is a good packaging slogan. Some manufacturers are using plastic inserts in blankets as a selling device; it gives more color to the display, in addition to giving added protection. It has been proved that visibility stimulates consumers' interest and that the consumer desires to see the merchandise he is buying. Examples of this are in the food industry where glass, transparent plastic films, window containers, and mesh bags have been used successfully for packaging dried fruit, fresh vegetables, nuts, rice, beans, peas, beets, meats, cheeses, etc. The psychology behind the visible packaging display of merchandise is that seeing creates a spontaneous or an impulsive desire-to-have. For example, many retail grocers who were unable to move particular merchandise such as bulk cheese, repacked the same merchandise in smaller attractive containers and, in doing so, were able to increase the sales of the merchandise substantially. One retailer indicated that many sales have been missed because the customer could not see what he was buying; transparency of containers and packaging is a moving force in consummating sales.

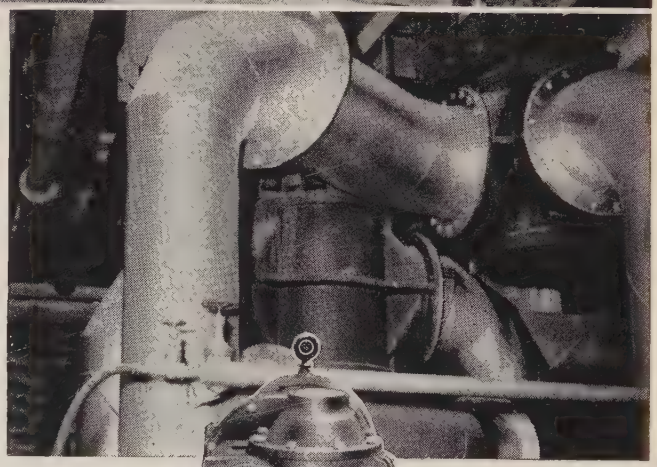
Whereas film packaging has been very successful as a sales stimuli, it has the opposite effect when not used properly. He cited the case where bargain hosiery wrapped in individually sealed packages was ignored, whereas, more expensive hosiery sold because the women could examine the merchandise more closely. Another retailer indicated that film wrapping was not adaptable to bargain merchandise because it tears, scatters, and creates a messy, untidy display. Also, one retailer stated that, unfortunately, some manufacturers use the guise of transparent packaging, i.e., freshness, cleanliness, etc., as a means for concealing inferior merchandise—merchandise not readily inspected as are unpackaged items. Nevertheless, the use of transparency, highly colored labels, receipts, etc., can and does do a good job of attracting and selling the consumer. The fact that customers increasingly pick out the most attractive packaged item is cited by one retailer. Better and more carefully arranged colors on all types of packages tend to improve sales appeal and to stimulate spontaneous or impulse buying. Most retailers feel that attractive, eye-appealing, well-protected, and confidence-inspiring packaging is much more effective than any other point of sale advertising media. Another example of the importance of eye appeal was cited by a shoe department manager, who stated that he hoped that women's shoes would come in window boxes which would not only present an attractive display, but more important, would aid women in making a decision.

LABEL ADVERTISING

Another desirable packaging feature, to which the re-



VALVES



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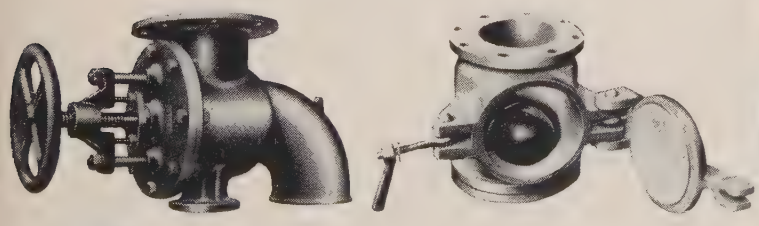

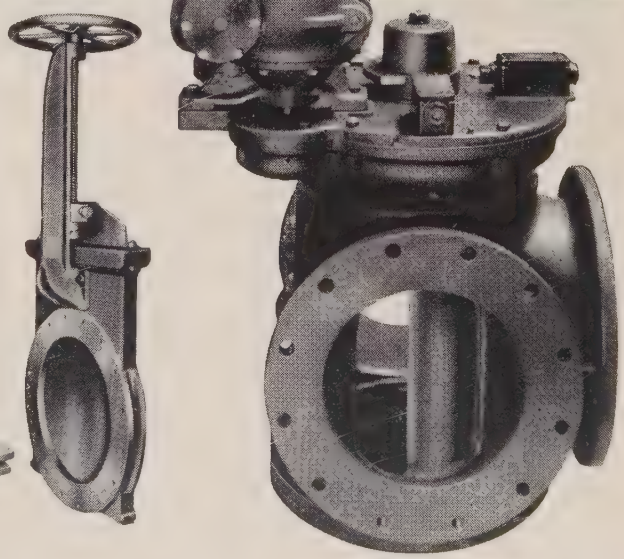

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tailers give credence, is the use of attractive, highly colored, distinctive informative labels which stimulate consumer's interest. A survey was conducted by one retail grocer using one package with the label containing only the name of the product and of the distributor and another package of the same merchandise with a bright, colorful, attractive label containing the name of the product and an appetizing picture of the contents. The result was, greater sale of the merchandise that had the attractive, brightly colored label. All respondents indicated that further improvement was needed in the labels used today. Labeling should leave no doubt as to the relative grade of the contents, how much is in the container, and, where appropriate, how it is prepared for use. It was noted, also, that sales have been increased when recipes and other suggestions for use of contents are included on the label.

The importance of reuse, after-use, or dual-use value of packages and containers was emphasized by many retailers. Two grocers remarked of the success enjoyed recently by a cottage cheese supplier who packaged his product in a plastic container which could be used as a flower pot or a refrigerator dish when the original contents were emptied. They indicated that it was very successful and that more items of this type should be introduced. It was noted that retailers like a fast moving item, and the consumer likes a package which he or she may find useful after the original product purchased has been used.

Another retailer indicated an increased trend in the demand for after-use plastic and ceramic containers. He indicated that such devices as a ceramic tea pot filled with tea leaves out-sold the conventional packaged tea, four to one. Also, packaging such items as soap, candy, and etc., in boxes that are later used for cigarette boxes, ash trays, refrigerator boxes, sandwich boxes, jewel boxes, has been very successful. One retail grocer suggested that the use of 12-ounce glass jars for jellies, preserves, etc., be adopted by the industry because all other glass jars are thrown away. An adverse comment on reuse containers was made by a large drug store retailer, stating that they were not enthusiastic about reuse containers and indicated that the consumer soon would not have sufficient space to store all such reuse, after-use, or dual-use packages.

Most retailers realizing the value of unit-packaged merchandise, indicated that sales could be increased if allied lines of merchandise such as razors and razor blades, or tooth brushes and tooth paste, assorted candy bars, etc., be combined in a single package. Unit packaging of such items as dishware, glassware, soaps, cheese, towels, sheets, etc., has met with a great deal of success. One retail druggist pointed out that the sale of powder puffs when placed six to a cellophane package greatly exceeded the sale of individually wrapped items. Similarly, packaging individually wrapped sections of cheese in a plastic container has been very popular. The sales volume of one sectionally wrapped food product increased five times when the entire packaged contents were so divided into smaller packages. One department store executive indicated that losses occurred when unit-packaged merchandise was broken open through error and sold at less than a full unit. If adequate information as to the number of items in unit-packages and all other pertinent data are clearly indicated, such clerical errors can be reduced.

Advertising has become a definite function of containers. Mass circular and rectangular display areas have eliminated the need for bulky space-consuming display cards and have been responsible for further refining the art of packaging. It was pointed out that packaging is most effective when closely coordinated with nation- or area-wide advertising campaigns. It is clearly recognized that packaging is one of the most effective advertising devices used by manufacturers.

PACKAGING SUGGESTIONS

Numerous suggestions were offered by retailers of specific conditions which they would like manufacturers and suppliers to take cognizance of in planning for future packages and containers. Some can be summarized as follows:

1. A container, so designed, that it could be used as a dispenser in the home, and thus, eliminate the need of transferring the contents from the original to another container.
2. Increase use of identical front and back panels on packages and containers.
3. Need for a "spot system" for more efficient pricing and checking of merchandise. This system would eliminate the need of looking on the top and bottom of packages to find the price. The large number of retailers making this suggestion indicated the great desire for such a "spot system."
4. Elimination of printing on closures, in lieu of the "spot system," to facilitate marking and checking merchandise.
5. Disliked is the practice of some manufacturers and suppliers enclosing advertising material in their packages which advertise other merchandise. It is embarrassing and creates ill-will when the related items advertised are not marketed by that particular retailer.
6. It is recommended that spouts be added to packages containing such dry flowing products as rice, cereal, etc., to facilitate pouring.
7. Need for more attractive dispenser-type packaging.
8. Desire for more premarking of merchandise by manufacturers and suppliers. Premarking would reduce the retailer's time and expense involved in this operation.
9. Need for placing small items on display cards which can be taken from behind the counter and placed in full view of the public.
10. Corrective action apparently is needed to reduce the amount of breakage of glass and cork stoppers used in containers.
11. Fruit and vegetable containers should be developed which would permit the retailer to replace that portion of the food which may have become discolored or otherwise deteriorated in the original sealed container, e.g., prepackaged tomatoes.

In conclusion, this sampling of opinion clearly indicates that the retailer is becoming increasingly aware of the important function packaging has in successful business operations.

Text reprinted from the Spring 1950 issue of *Containers and Packaging Quarterly Industry Report.* A sampling of opinion on the subject "The Retailer Looks at Packaging" was made during the month of January, 1950 by selected U. S. Department of Commerce field offices. The digest of these field reports was made by the Containers Section, General Products Division, Office of Domestic Commerce.

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. . . for your customers and you

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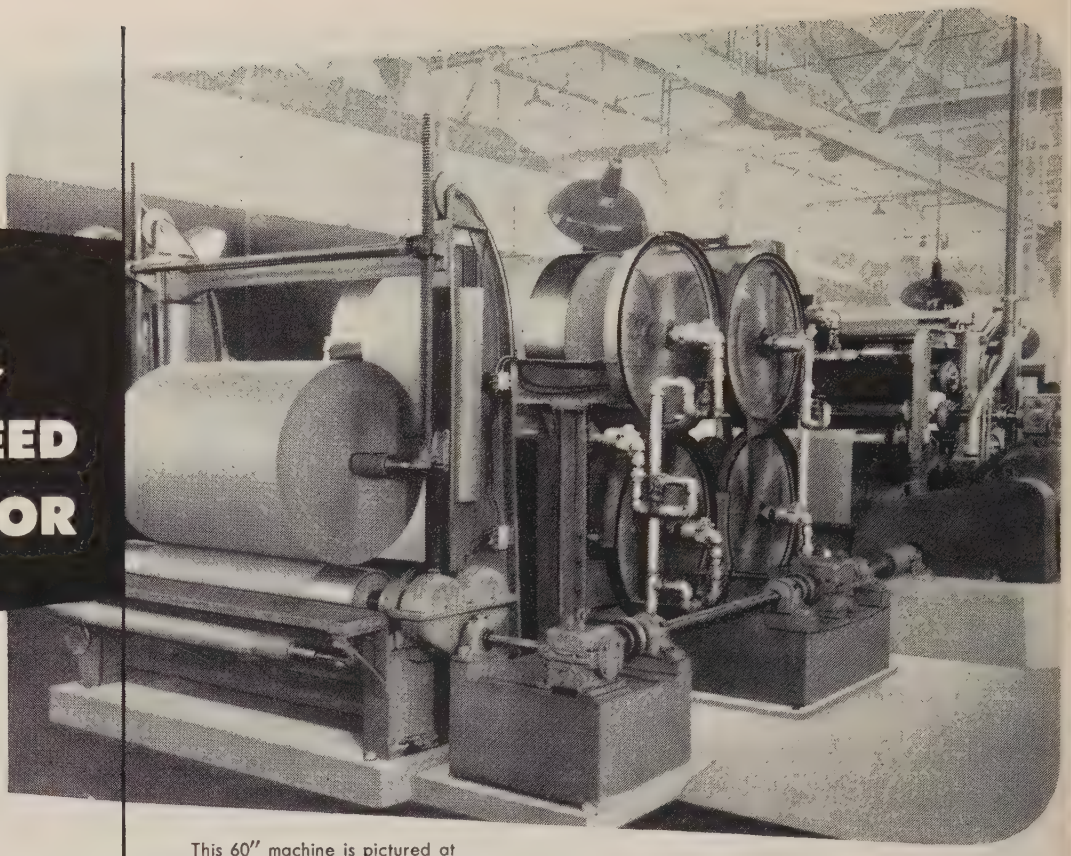
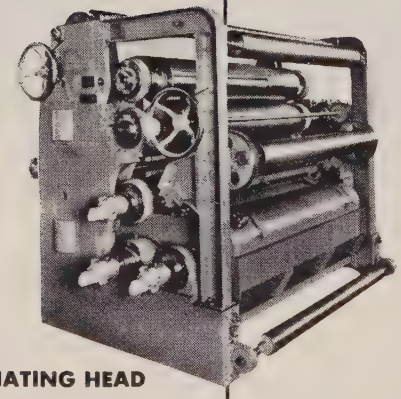
BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

Egan HIGH SPEED LAMINATOR



This 60" machine is pictured at INTERNATIONAL PAPER COMPANY (Bagpak Division) ... has been operated over 1100 ft./min. in speed. Double drum winder end is shown viewing drive side.

designed for 1000 ft./min. operation



DETAIL OF LAMINATING HEAD

- ***Welded steel-frame construction keeps vibration down to a minimum***
- ***Anti-friction bearings throughout***
- ***Upper applicator roll activated by air cylinder for quick throw-out against adjustable micrometer stops for controlled, accurate metering of adhesive.***

Write for quotation or invite our representative to call. Pamphlets on coating, treating and laminating sent on request.

FRANK W. EGAN & COMPANY
Bound Brook, New Jersey

Designers and builders of: Treaters, Gummers, Laminators, Crepers, Air Dryers, Waxers, Coaters, Festooners, Saturators, Printers, Embossers, Winders and Special Machinery for Paper Converting.

Cable Address: "EGANCO"—BOUNDBROOK, N. J.

for products that are poured ... and stored

Container courtesy American Can Co.

Container papers benefit from Cyanamid Paper Chemicals

Paper is going places these days, and doing things well which previously only more expensive materials could do. For instance, paper milk containers such as the one shown here are finding increased acceptance from the consumer—containers welcomed for their sturdiness, light weight, small space requirements and easy disposability.

In this forward march of paper to new markets, Cyanamid's paper chemicals are playing an important role. Cyanamid's ALWAX* Sizes, for example, impart such desirable qualities as resistance to water, lactic acid, and blood serum combined with better folding, creasing, scoring and crimping properties. Thus, paper becomes an ideal container material for frozen foods, dairy products, prepackaged foods . . . three huge markets right there!

Are *you* looking for new markets to conquer? Then contact your Cyanamid representative and tell him what properties you want in your papers and what markets you wish to reach. His recommendations will constitute a big first step toward reaching those markets where greater sales, more profits lie. *Trade Mark

ALWAX* Sizes • WAXINE® Sizes • Rosin Size • PAREZ® Resins
Synthetic Resins • Casein • Sulfonated Oils • Fillers • Defoamers
Soda Ash • Caustic Soda • Salt Cake • Acids • Clays • AEROSOL® Wetting Agents • CALMICRO* Calcium Carbonate • AZITE* Liquifier 900 • Aluminum Sulfate • Sodium Phospho Aluminate.
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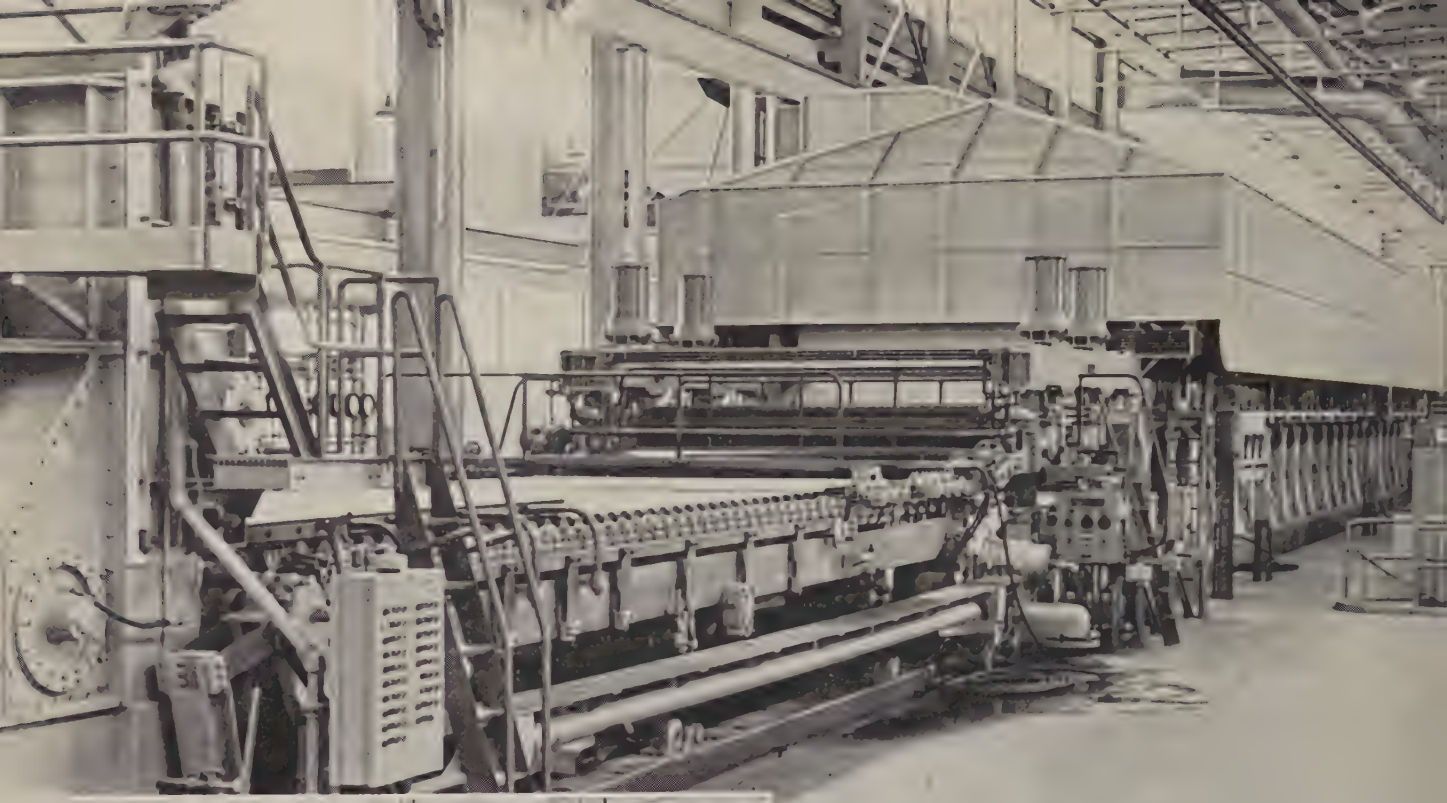
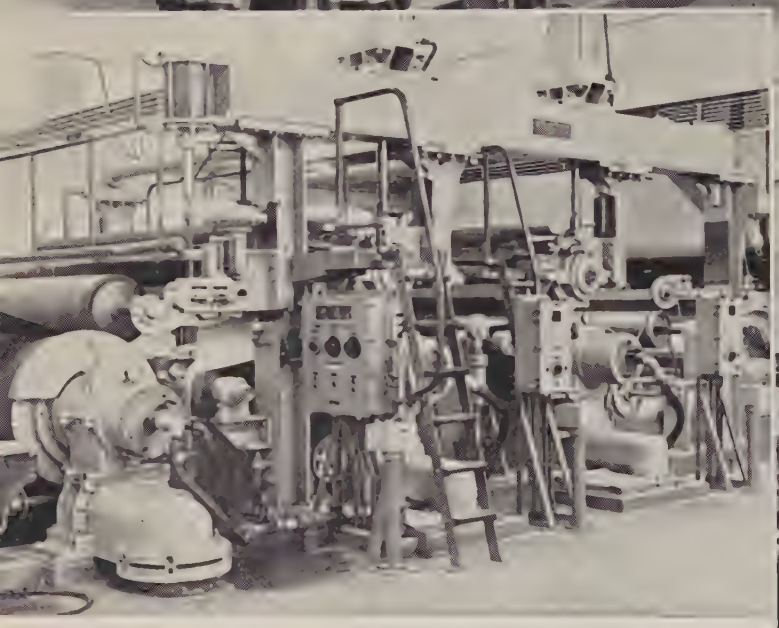
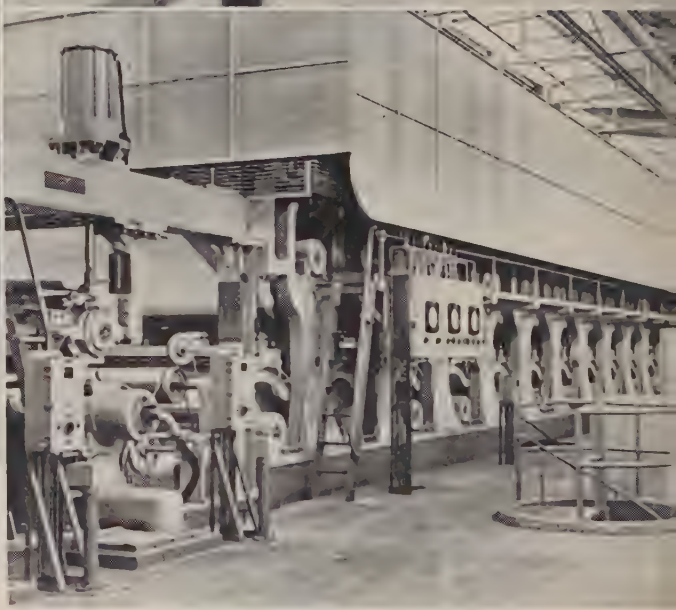
Sales Offices: Boston • Philadelphia • Pittsburgh • Baltimore Charlotte • Cleveland • Cincinnati • Chicago • Detroit • Kalamazoo St. Louis • Los Angeles • San Francisco • Seattle. In Canada: Dillons Chemicals Co. Ltd., Montreal and Toronto.

AMERICAN Cyanamid COMPANY
INDUSTRIAL CHEMICALS DIVISION, DEPT. T 6
30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.







FEATURES OF 156″ PUSEYJONES FOURDRINIER MACHINE AT FIBREBOARD

Improved type Flow Spreader combined with 8 ft. high head adjustable slice, all Neoprene lined.

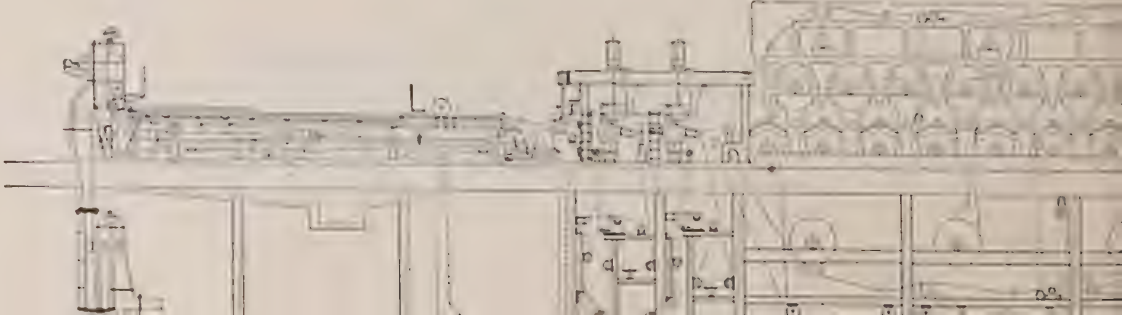
Fourdrinier Part suitable for a wire 100 ft. long and 156″ wide, equipped with 36″ suction couch, lump breaker roll with improved raising and lowering mechanism, 7–7″ wide suction boxes, dandy roll, "Rapi-drape" wire changing device, and adjustable wire pitch arrangement.

Press Part of Simplex close-coupled design with 28″ rubber covered first and second main presses and Vickery felt conditioners.

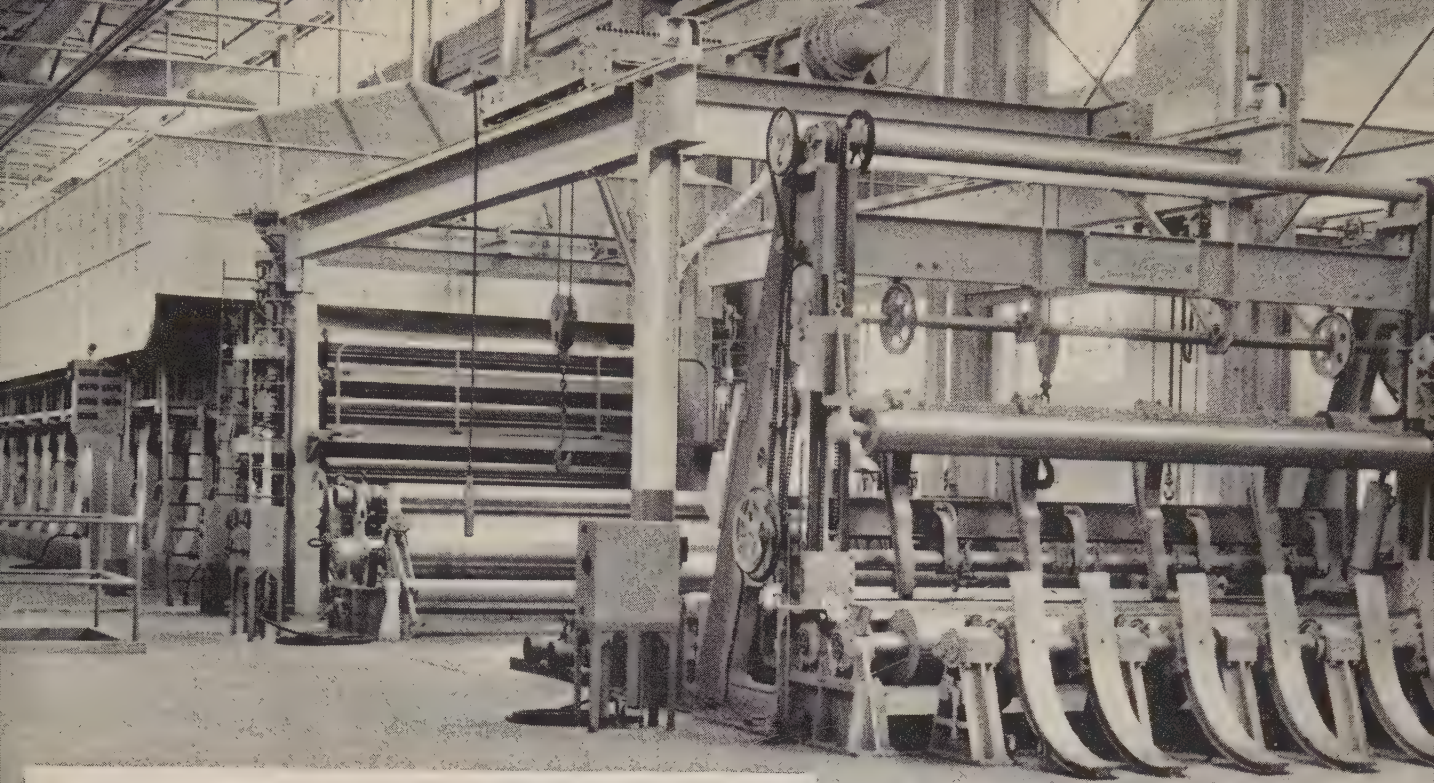
Dry Part in two main sections having one upper and lower felt on each section; first section comprises 20–60″ paper and 6–60″ felt dryers; second section comprises 20–60″ paper and 2–60″ felt dryers; Bowser lubricating system and main dryer bearings; rope carrier device for threading the sheet through the dryer sections; improved type enclosed gearing, latest type steam joints with dual revolving siphons, and automatic motor-operated felt tension control devices. Calender Stack comprising 7 rolls with independent Bowser oiling system for all roll bearing pneumatic nip loading syst

Pope type Uniform Speed improved design, with pn adjustable loading mechani

Puseyjones Winder with h operated roll unloading mec



Line drawing of new machine. Maximum speed is 1200 feet per minute with G.E. multiple generator type sectional electric drive.



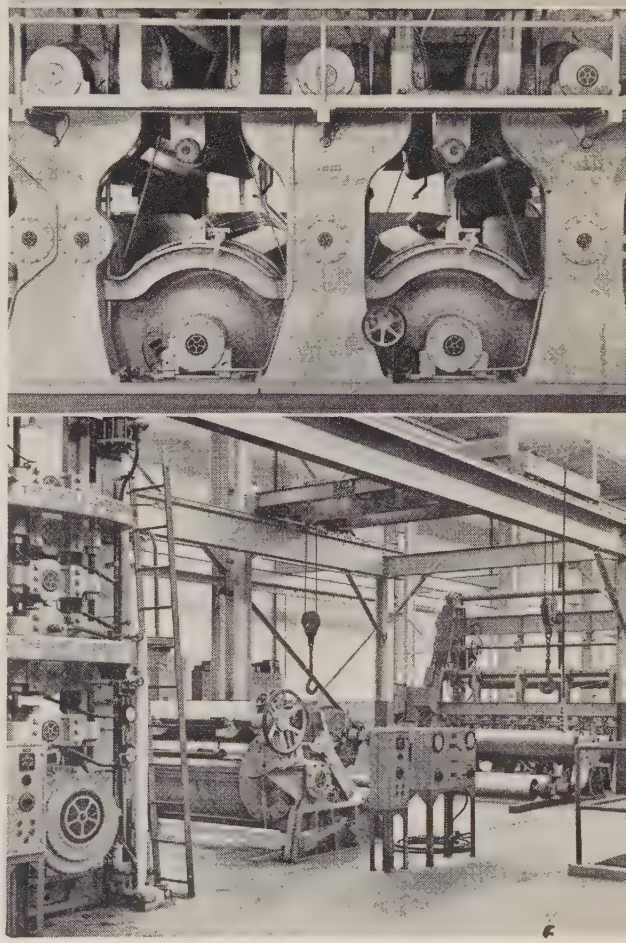
ANOTHER FIRST FOR FIBREBOARD

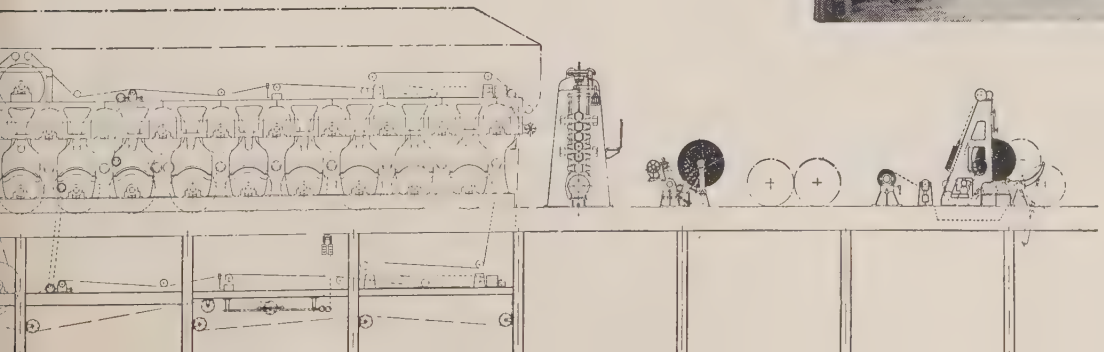
Here is the Puseyjones Fourdrinier Machine now in operation in the fine new mill of Fibreboard Products, Inc., East Antioch, California. In every detail from wet end to winder, the new machine reflects the latest developments in the papermaking art. It is producing .009 corrugating paper from furnish prepared by the latest semi-chemical process.

Whatever your papermaking problem, put it up to Puseyjones—for machines that give continuous, uniform production at high speeds.

THE PUSEY AND JONES CORPORATION
Established 1848. Builders of Paper-Making Machinery
Wilmington 99, Delaware, U.S.A.

THE SIGN OF TRADE MARK SUPERIOR QUALITY





All rolls in the new Puseyjones Fourdrinier Machine at Fibreboard are equipped throughout with roller bearings, with the exception of lower calender roll.

The Use of Radioisotopes for Process Control in Pulp and Paper Manufacturing

A. P. SCHREIBER

New developments, both scientific and political which are announced daily in the press have served to make us all realize that the atomic era is already beginning to affect us in a great many ways. Up to date there have been only a few concrete indications that industry has benefited by atomic discoveries. However, it is believed that substantial industrial progress will be made within the next few years by the use of byproducts of the atomic project. In the author's opinion the group of byproducts called radioisotopes warrant much more immediate and serious consideration by industry than they have received up to the present time. These materials are available for immediate use and have been distributed by the Isotopes Branch of the Atomic Energy Commission for over 3 years.

Fundamental researchers, particularly in biology, medicine, and agriculture, have already put radioisotopes to work as evidenced by the fact that well over 90% of the more than 10,000 radioisotopes shipments from the Oak Ridge atomic pile have gone to groups whose primary interests are in the more fundamental aspects of research. Industrial research groups using radioisotopes have accounted for only a few per cent of the total. It is believed that industry has been unduly slow to embrace the use of this new tool, and as a consequence, is only beginning to realize the value of this extremely effective means for solving many of its technical problems.

Of course the most obvious reason why industry has not begun more widespread use of radioisotopes lies in the fact that there are relatively few technically trained people who have the necessary specialized background to evaluate just what might be accomplished with radiosiotopes or know how to go about setting up and operating the necessary specialized facilities which are required. The equipment which one needs to work with radioisotopes is not extremely expensive nor does it require unusual skill to operate. It is not difficult for technically trained personnel to obtain the requisite specialized background for carrying out research projects involving radioisotopes. The Oak Ridge Institute for Nuclear Studies offers a 4-week course to acquaint such personnel with the necessary basic information. This course is available throughout the year and a number of representatives of industry have already taken advantage of this opportunity.

PRODUCTION OF RADIOISOTOPES

Before outlining a few typical uses of radioisotopes, a short description will indicate how these materials are produced and what their unique characteristics are which permit them to do many jobs which have been heretofore impossible of achievement with conventional techniques. Radioisotopes are produced in several ways. They can be made by subjecting stable chemical compounds to intense bombardment by neutrons in the atomic pile at Oak Ridge during the process in which plutonium, the raw material for the bomb, is made. Neutron bombardment causes changes to occur deep within the atomic nucleii of the compound in question and produces instability. These unstable atoms can regain stability only by emitting radiation—either alpha, beta, or gamma rays. Ultimately all of these atoms will return to a stable state. The time it takes may vary from a fraction of a second to millions of years depending upon both statistical probability and the chemical composition of the material which was bombarded. Until the moment when they emit radiation, these unstable atoms cannot be distinguished from their stable counterparts. For example, a quantity of sodium chloride or common table salt which has been bombarded with neutrons in the atomic pile will act chemically and physically exactly the same as ordinary sodium chloride. If a very small amount of radioactive salt is mixed with ordinary salt it is possible to trace the progress of the mixture through a complicated series of reactions by means of a Geiger tube which is used to measure precisely radiation released as the atomic nucleii return to a stable state. It is due to this characteristic of following its stable counterpart and making its presence known by emitting radiation that a radioisotope is often called a "tracer."

There are two other sources of artificial radioisotopes. They can be produced in small quantities in cyclotrons by bombarding stable elements with accelerated nuclear particles. They are also produced as byproducts in the fission reaction of uranium or plutonium in which these materials liberate energy and are split into elements of lower atomic number. This fission reaction takes place in the atomic pile and consequently at Oak Ridge enormous quantities of these radioactive fission products are available for use as tracers after chemical separation from irradiated uranium and plutonium slugs from the atomic pile.

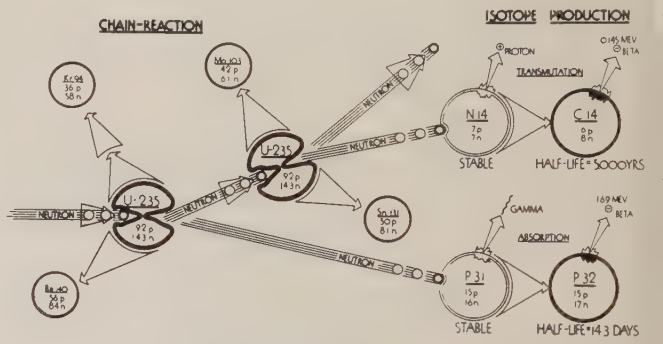


Fig. 1. Methods for production of radioisotopes **(ID-USAEC)**

Figure 1 shows the two basic methods by which radioisotopes are produced in an atomic pile. At the lower left part of this diagram a neutron is colliding with an atom of uranium-235. This collision causes the uranium atom to split into two lighter atoms, liberate heat energy, and emit one or more neutrons. These atoms produced by the splitting of uranium are called fission products and are radioactive. The fission products indicated in this diagram are barium-140, krypton-94, molybdenum-103, and tin-131. If a compound containing stable phosphorus-31 is placed in an atomic pile it will be bombarded by some of the excess neutrons which are produced by the splitting of uranium atoms. Some of this table phosphorus is changed to a radioactive form, phosphorus-32, which emits beta radiation. Still another type of reaction caused by neutron bombardment is possible. For instance, if a compound containing the stable isotope nitrogen-15 is placed in a pile, it is changed to a different element, carbon-14, which emits low energy beta radiation.

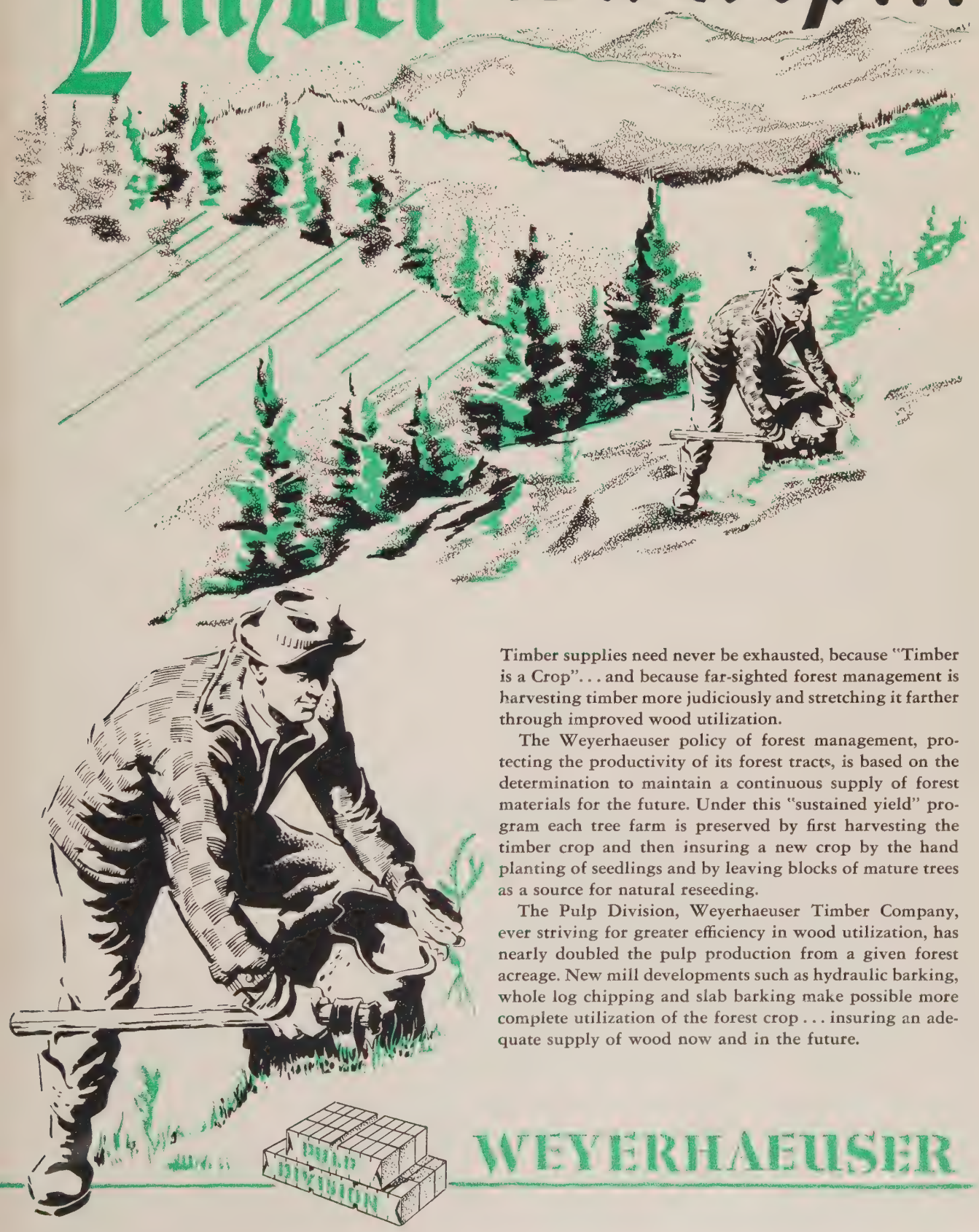
Up to the present time the Atomic Energy Commission has made available for distribution about a hundred different radioactive isotopes of approximately sixty elements. All of these radioisotopes are produced in the atomic pile at Oak Ridge and shipments are made from there to users all over the world.

GAGING AND PHYSICAL MEASUREMENT PROBLEMS

One of the most promising uses of immediate application to industry is in gaging and physical measurement problems,

A. P. Schreiber, Tracerlab, Inc., Boston, Mass.

Timber is a crop...



Timber supplies need never be exhausted, because "Timber is a Crop"... and because far-sighted forest management is harvesting timber more judiciously and stretching it farther through improved wood utilization.

The Weyerhaeuser policy of forest management, protecting the productivity of its forest tracts, is based on the determination to maintain a continuous supply of forest materials for the future. Under this "sustained yield" program each tree farm is preserved by first harvesting the timber crop and then insuring a new crop by the hand planting of seedlings and by leaving blocks of mature trees as a source for natural reseeding.

The Pulp Division, Weyerhaeuser Timber Company, ever striving for greater efficiency in wood utilization, has nearly doubled the pulp production from a given forest acreage. New mill developments such as hydraulic barking, whole log chipping and slab barking make possible more complete utilization of the forest crop ... insuring an adequate supply of wood now and in the future.

WEYERHAEUSER

It is this type of use which will be of most general interest to those who are particularly interested in making more and better paper at lower cost. By methods which have been recently developed, it is possible to carry out very precise measurements continuously during the production process without contaminating the product with radioactivity in any way. The first of these is a noncontacting basis weight gage which takes advantage of the fact that beta radiation is absorbed or stopped in proportion to the weight per unit area of an absorber or filter placed in its path.

As nearly everyone in the paper industry knows, there have been many attempts to obtain a continuous indication of basis weight directly on the paper machine during the past few years, but to date all methods have had serious limitations. A number of micrometer gages have been used for continuous thickness measurements, but in general they become inaccurate through wear of mechanical parts and even more serious, do not indicate in units which can be satisfactorily converted to basis weight. Continuous weighing scales also have serious drawbacks since they are also mechanical devices which must contact the paper sheet. Optical type gages using a light source and a photocell have been used with limited success on materials possessing a reasonably high and constant degree of transparency per unit thickness.

Another gage consists of a parallel plate condenser through which runs the sample to be measured. Variations in the mass or the dielectric of the sample will cause a change in the capacity of the system. Also, changes in composition have a serious effect upon the gage reading. For example, an increase of only 1% in moisture of a paper sheet will give the same change in gage reading as an increase in pulp content of 40%. X-radiation has been used for gaging but it is useful only for heavy materials such as sheet steel and possesses the disadvantages of high initial cost and frequent maintenance.

Prior to the war there was a limited realization that beta rays might be of use in gaging problems but little was done about it because there was no source of reasonably priced beta emitting radioisotopes with the required characteristics. During the past two years, with the assistance of radioisotopes made available by the Atomic Energy Commission, considerable research work has been carried out which has resulted in a series of gages which possess almost none of the disadvantages inherent in all other gaging methods which have been mentioned. A brief description of the mechanism of beta ray absorption and the basic components of a beta ray gage will suffice to show some of the advantages of using nuclear radiation for many industrial gaging problems.

Beta particles, which are electrons of high energy, are slowed down or stopped by electrostatic interaction with electrons normally present in all matter. The thickness of material necessary for complete absorption or stoppage depends upon the energy of the beta particles and upon the density of interacting electrons present in the absorbing medium. The weight per unit area of absorber required to completely stop a beta particle is independent of the nature of the absorber because the number of electrons in a given mass of material is substantially independent of its composition. Thus, it can be stated that beta ray absorption gages operate almost completely independently of the composition of the sheet being measured. Variations in moisture content or chemical composition have no effect upon the gage reading except insofar as these variations contribute to a change in its weight per unit area. The information obtained with a beta-ray absorption gage is analogous to that which the quality control laboratory technician obtains when he weighs a known area of paper on a balance. Just as in the use of the balance, a beta gage can be calibrated to read directly in terms of basis weight or other units which express weight per unit area.

The basic components of a gage which is suitable for continuously recording variations in basis weight directly on the paper machine are a source of beta radiation from a radioisotope, a detector, and amplifier, together with a suitably calibrated recorder. The source is contained in a long cylindrical holder and has a sensitive length of 15 inches. The detector is mounted above it and consists of an ionization chamber, a small amplifying circuit, and mechanism for automatically carrying out periodic standardization. The sheet material being gaged runs continuously between the source and detector, absorbing a part of the beta radiation in proportion to its weight per unit area. The radiation which penetrates the sheet is measured by the detector and after amplification the signal is used to actuate a calibrated strip chart recorder.

A small laboratory absorption-type beta gage which contains the same basic components and operates on the identical principle as the gage previously described is also available. A slot with an opening in the front of the instrument is provided to permit large sheets of materials to be measured. This instrument should prove particularly useful for paper mill quality control laboratories which desire to obtain fast basis weight measurements across the width of the sheet. All that is necessary is to insert a long sheet which has been torn off across the width of the paper roll and pull it slowly through the gage stopping only to make accurate spot checks at desired intervals. It is also possible to make recordings of the profile of a sheet by the addition of a standard recorder.

For most gaging purposes the source of radiation is strontium-90 which emits beta rays of medium energy and its decay product yttrium-91 which gives off beta rays of somewhat greater penetrating power. Strontium-90 has a half life of 25 years which means that a source of this material loses one-half of its remaining activity every 25 years. Such a long half life is extremely advantageous since the radioisotope need not be replaced more often than once every 20 or 30 years. This source can be used on sheets weighing up to 700 mg. per sq. cm. which corresponds to about 0.3 inch of wallboard.

In cases where a heavier sheet is to be measured it is possible to use ruthenium-106 which emits very high-energy beta rays capable of penetrating material weighing up to 1 gram per sq. cm. However, ruthenium-106 has the disadvantage of a relatively short half-life of a year which makes its use undesirable except when it is necessary to attain the added penetration. For material weighing more than 1 gram per sq. cm. it is necessary to resort to the more penetrating radiation of gamma rays which present a number of problems which need not be faced when beta radiation is used.

Ionization chambers were chosen as the radiation detecting elements of these thickness gages rather than Geiger tubes because they permit use of higher radiation intensity levels at which statistical inaccuracies due to the random nature of beta particle emission from the source are strongly reduced. Furthermore, an ionization chamber never wears out. At the high radiation intensities which are used, a Geiger tube either becomes "blocked," or its useful life is reduced to the point where frequent replacement is necessary.

In addition to merely measuring total weight per unit area of a sheet, these gages can be adapted to measure the amount of coating added to a sheet. For example, they can be used to measure coatings such as wax, asphalt, or the amount of glue added to paper stock in making labels, independently of variations occurring in the paper stock. This measurement is taken by the use of two gages. One is mounted at a point just before the coating process and the second is used to take a measurement just after the sheet is coated. The two are connected together and the output of the second is electrically subtracted from that of the first giving a direct reading of weight per unit area of coating added.

BACKSCATTERING GAGES

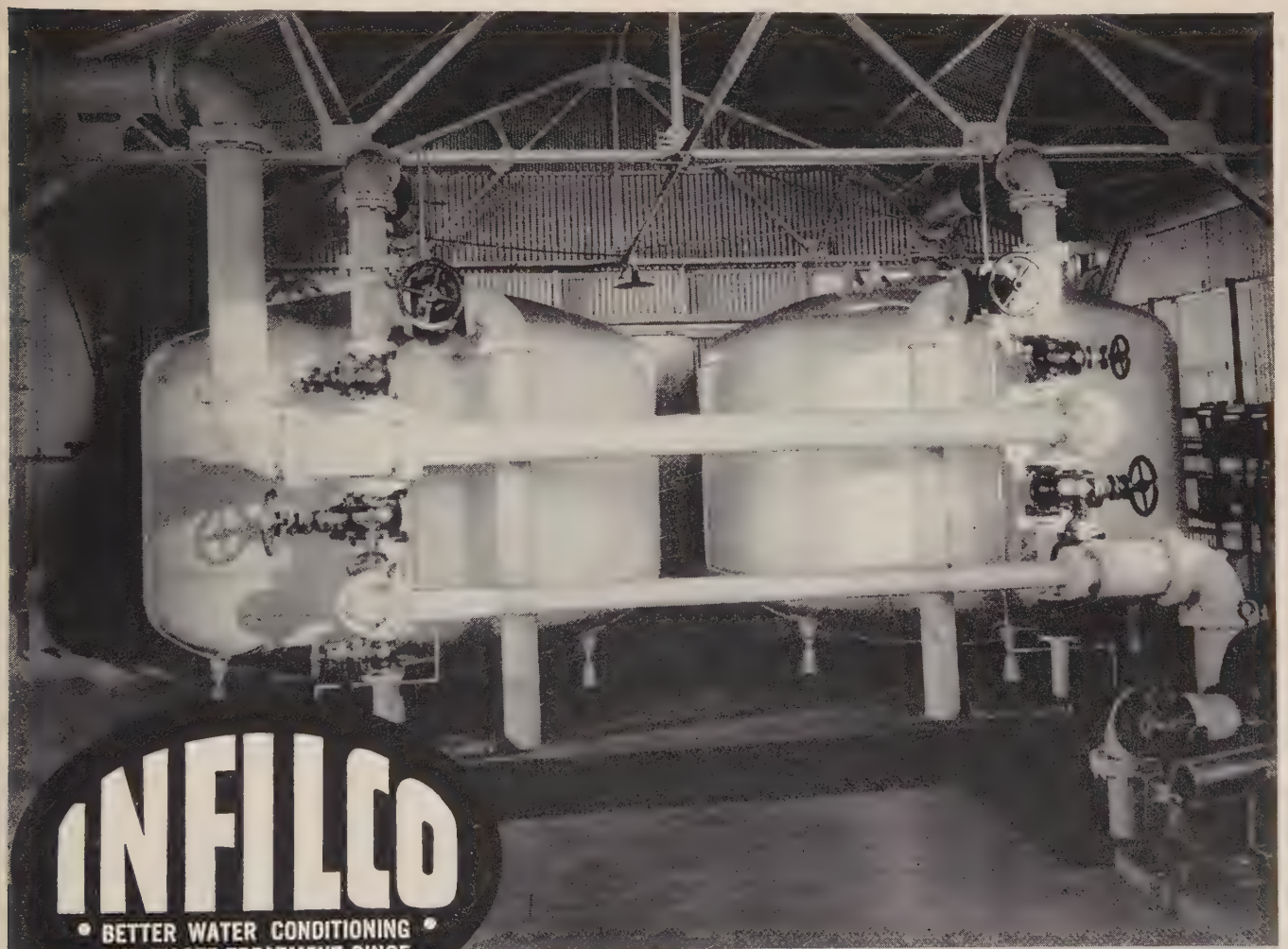
Another recently developed instrument uses a backscattering measurement technique for extremely thin paper such as

IMPROVE LIQUOR QUALITY
WITH COOKING LIQUOR FILTERS . .

INCREASE CHEMICAL RECOVERY
WITH ACCELERATED CHEMICAL CAUSTICIZING . .

COOKING LIQUOR FILTERS complete the removal of suspended matter in the liquor delivered to the digesters. This permits an increased paper brightness with the use of less bleach and without loss of strength. In addition, digesters show less tendency to scale after the cooking liquors have been filtered.

ACCELERATED CHEMICAL CAUSTICIZING is a process which combines two well-known methods—coagulation and causticizing. Their joint use in a single process results in, 1. A more complete recovery of reusable chemicals, 2. Accelerated settling of solids, 3. Cleaner liquors, and 4. Control over "hard to settle" sludges. Clarifiers are free from internal moving parts. Separate units for each step of the process permit positive yet flexible control. Meters record flows. Proportioners automatically control diluent liquors and discharge valves. Lime feeder and slaker operation is automatic, the amount of lime fed is recorded and controlled in proportion to the flow of liquor. INVESTIGATE the advantages of Cooking Liquor Filters and Accelerated Chemical Causticizing. Our Chicago Office or Field Engineers will be glad to supply you with additional information, without obligation.



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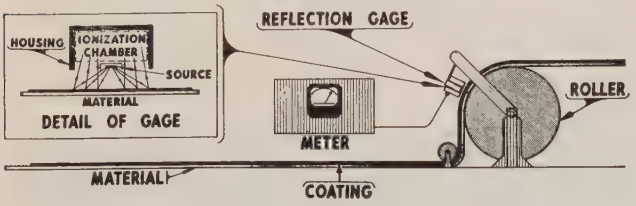
cigarette, tissue, and condenser paper and for measuring certain types of coatings as, for example, barium sulphate coated paper which is used in making photographic printing paper. It can also be used for determining coating thicknesses of such materials as tin coating on can stock, lacquer on beer cans, and the amount of rubber or plastic spread on a calender roll just prior to its application to a textile backing.

The sensitivity of this gage is exceptionally high for thin coatings. For example, in a production line test it was found to be capable of measuring extremely thin coatings of tinplate to an accuracy of a few millionths of an inch even though there were substantial variations in the steel sheet on which the tin was plated. An illustration of the basic components of such a gage is shown in Fig. 2. An ionization chamber is used as a radiation detector. This chamber contains a thin "window" of stainless steel or brass to permit entry of beta radiation into the chamber for measurement. A source of beta radiation in a heavy metal holder is mounted outside



Advantages: (1) can measure thickness of coating and/or material; (2) measurement made from one accessible side; (3) can measure a variety of materials with one calibration.

Fig. 2. Radioactive source for reflection (backscattering) thickness gage

(ID-USAEC)

and in the center of the chamber "window." The geometrical position of the source and holder is such that no radiation can pass directly into the chamber since the metal source holder is sufficiently heavy to absorb all radiation which impinges on its walls. If the source and detector are placed an inch or two away from any surface, a part of the radiation will be backscattered or reflected by the surface and received by the detector. The amount of backscattering which takes place is a function both of the atomic number and thickness of the material causing the backscattering. The higher the atomic number, the greater will be the amount of backscattering.

A piece of the plastic material is squeezed out into a thin film on a metal cylinder by heavy steel rollers. The backscatter gage is placed in close proximity to the calender roll on which is spread the thin plastic film. The relatively high atomic number of the steel roll causes a considerable amount of incident radiation to be backscattered. A constant reading of backscattered radiation is obtained from the bare steel roll since it is thicker than the maximum penetrating range of the beta emitter. When the plastic film is spread on the roll, the amount of backscattered radiation will be decreased. The plastic, having a fairly low average atomic number, will backscatter the incident radiation only slightly. A part of the incident radiation is absorbed in passing through the plastic to the steel roll and an additional quantity is absorbed by the plastic as it returns by backscatter off the steel roll. This decrease in radiation received by the ionization chamber detector can be accurately measured and read off the gage directly in terms of plastic film weight per unit area or thickness when the gage is properly calibrated. In a similar manner a backscatter-type gage can also be used to measure a large number of other types of films such as paint on steel, electroplated films of metal on a wide variety of objects. A prerequisite of successful use of this method is that the film coating and the base material be of substantially different average atomic number. It would be impossible, for example, to measure a coating of plastic on a backing of paper or textile by the use of the backscatter technique.

Use has already been found for both the backscattering and absorption-type beta ray gages to continuously indicate variations in products such as paper, plastic, sheet steel and brass, and textiles directly on the production line. Wider use of these gaging techniques will undoubtedly produce materials conforming to much closer manufacturing tolerances since an accuracy of 1% or better can readily be attained.

SPECIFIC GRAVITY MEASUREMENTS

By application of the beta-ray absorption phenomenon, it is possible to carry out other measurements which are difficult to achieve on a continuous basis with available conventional instruments. For example, measurement of specific gravity of a nonhomogeneous system is quite feasible with radioactivity. In the manufacture of foam rubber objects, air is blown into liquid latex which is then cast into the desired shape. Conventional instruments are unsuitable for obtaining a continuous measurement of specific gravity of the liquid latex and air mixture. A specific gravity gage using a radioisotope is easily made by fabricating an ionization chamber detector in the form of a pipe, and a thin wire containing the radioactive source is suspended along the axis of this pipe. Variations in the specific gravity of the mixture will permit radiation to enter the detector in proportion to the weight per unit volume of the mixture. The gage can be calibrated to read directly in specific gravity. A similar method can be adapted to the measurement of solid and gaseous mixtures or to gases alone. Results obtained to date indicate that an extremely high degree of precision is possible by a specific gravity gage of this type. However, this method of measurement is generally limited to instances where the specific gravity of the material in question is substantially less than one due to the low penetrating power of beta radiation.

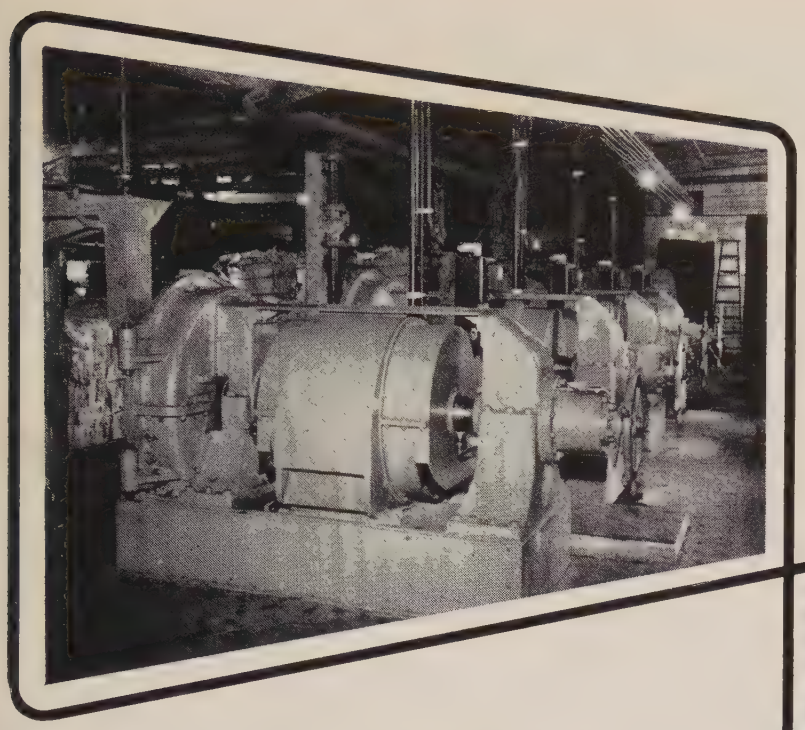
TRACER TECHNIQUES

There is a second category of uses for radioisotopes which should be of interest to the pulp and paper industry. As previously stated, radioisotopes can be used as tracers to follow certain constituents through a series of chemical reactions or to carry out flow studies. It is not anticipated that tracer techniques will enter into the day-to-day routine operations in a paper mill but rather will be used as a tool to solve special problems in the research laboratory, in the pilot plant, or occasionally in the full scale plant process. For example, in the research laboratory radioisotopes can be used to tag certain constituents to learn more about their dispersing ability under controlled conditions or to study some of the reaction mechanisms involved in the chemical pulp manufacturing processes.

As tracers, radioisotopes can be of assistance in problems involving air and stream pollution from industrial wastes. Let us consider a specific case. A chemical manufacture was dumping large quantities of industrial waste into a river emptying into the ocean. Nearby was a bed of oysters, the quality of which had deteriorated during the past several years. The fisherman who owned these oyster beds believed that the chemical plant was at fault and filed a suit for damages. The management of the chemical plant was convinced that the waste which they put into the river was not polluting the oyster beds.

Radioactivity can conclusively prove whether there is any basis to the fisherman's claims. All that is necessary is to mix a few millicuries of a radioisotope with the chemical waste as it enters the river, take samples of water in the oyster beds and make an assay of their radioactivity content with a Geiger tube. In that way it is possible to detect even a few parts per billion of the chemical waste water.

It is usually extremely difficult to obtain precise material balances with a paper mill and to know just where various



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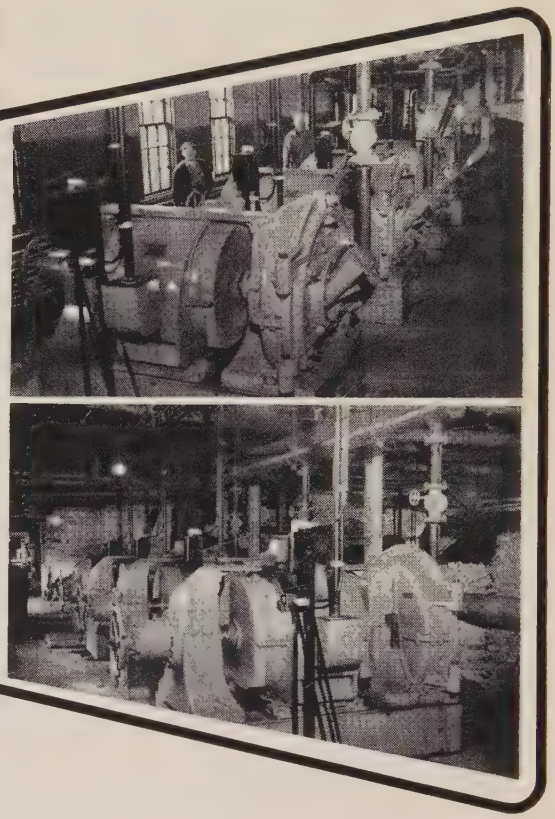

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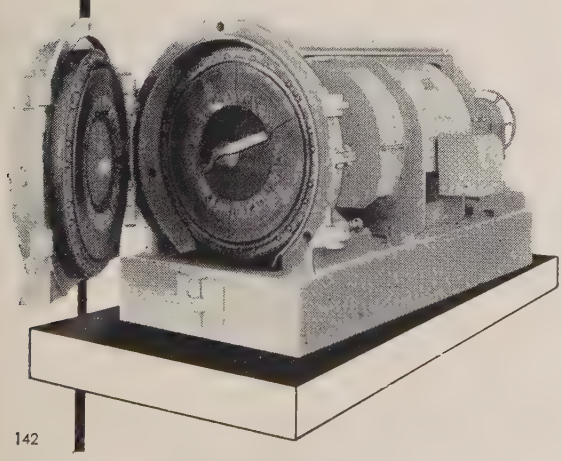

Sprout-Waldron Refiners do an excellent job in any kind of pulping, but in semichemical operations they far outperform similar equipment. They do more, do it better, and at less cost.

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components go. For example, it may be desired to follow the flow of white water starting at a particular point. How much goes down the sewer? How much of the fines contained in it end up in the paper sheet? Where does the remainder go? It should not be difficult to tag a portion of white water with a radioisotope of reasonably short half life and follow it with a Geiger tube. Samples of pulp, finished paper, white water at other points, and sewer effluent are taken and placed under a Geiger tube. If radiation is found to be emitted from any of these samples it indicates that some of the components of the tagged white water are present. Obviously some care would be required in carrying out a study such as this but fortunately, radioisotopes with short half lives are readily available and if properly used, no excessive contamination need occur.

IMPROVING PROCESS EQUIPMENT WITH RADIOISOTOPES

It is the author's belief that the application of tracer techniques by certain other industries will eventually prove of inestimable benefit to pulp and paper manufacturers. Research involving the use of radioisotopes is now underway by metallurgists and petroleum chemists which will ultimately result in greatly improving the alloys which go into the manufacture of equipment used in all paper mills. Progress is being made in finding out more about the mechanisms by which corrosion occurs. Fundamental studies are being made to determine just what happens when bearings wear by friction. The mechanism by which additives improve the lubricating qualities of oil has been studied. Many other research projects using radioisotopes are underway which will bring ultimate benefit to all industry in the form of better materials for the construction of process equipment and better means for the maintenance of such equipment. Let us examine several techniques which have been used in several of these studies.

Consider the situation of a manufacturer of gear pumps who wanted to find a more wear resistant alloy from which to fabricate his gears. It would take 1 to 2 years to evaluate the wearing qualities of each gear if conventional techniques were used since the metal is worn away at such a slow rate that a considerable time is required to obtain a measurable change in dimensions or weight of the part in question. This manufacturer wanted the answer within a month or two. Here is how it could be done with radioisotopes.

Since the gears were fairly small and made of metals easily convertible into radioisotopes by neutron bombardment, they could be made radioactive by placing them in the Oak Ridge pile for a few weeks. This is a service routinely made available by the Atomic Energy Commission. These activated gears could then be placed in an appropriate gear pump which is used to cycle the liquid in question in a closed system. Samples of the liquid are then taken periodically every few days and placed under a Geiger tube. The amount of activity in the liquid is measured quantitatively and converted into weight of metal eroded per unit volume of circulating liquid. In this way, much greater sensitivity can be attained under properly regulated conditions than by conventional chemical methods. In some instances wear of as little as a millionth of an inch of metal can be easily measured by a technique such as this.

The darkening effect of radiation on a photographic film is frequently useful in making a detailed study of the disposition of radioactive material. For example, the microscopic distribution of a tracer isotope in biological tissues is readily studied by observing a piece of film which has been exposed to such a tissue. When properly interpreted, the developed film indicates not only the presence or absence of radioactivity, and hence the location of the tracer itself, but also the relative concentration of the tracer as a function of position. The most intensive use of this technique which is called radioautography has been made in the field of biology, but the chemist and metallurgist also find it a useful tool.

Figure 3 illustrates two ways in which the radioautograph technique is used in friction studies. The upper portion of the sketch shows two blocks of metal, one of which is radioactive. One of these metal pieces is slid over the other. The amount and location of metal transferred by the radioactive block is easily determined by placing a photographic film on the block of ordinary metal. Dark spots found on the film after development indicate the location of minute metal particles torn off the radioactive block by friction.

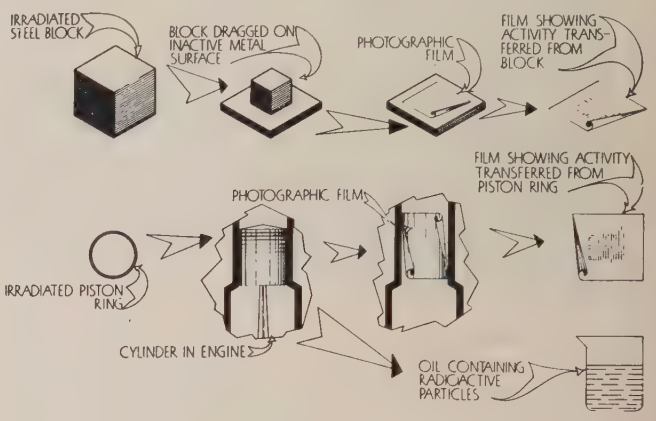
IRRADIATED STEEL BLOCK
BLOCK DRAGGED ON INACTIVE METAL SURFACE
PHOTOGRAPHIC FILM
FILM SHOWING ACTIVITY TRANSFERRED FROM BLOCK
FILM SHOWING ACTIVITY TRANSFERRED FROM PISTON RING
PHOTOGRAPHIC FILM
IRRADIATED PISTON RING
CYLINDER IN ENGINE
OIL CONTAINING RADIOACTIVE PARTICLES

Fig. 3. Friction studies using radioisotopes. **(ID-USAEC)**

The lower portion of the sketch shows a piston ring which has been radioactivated. The ring is placed in an engine cylinder and run for a period of time. The piston is then removed and a photographic film is placed in contact with the wall of the engine cylinder. Dark tracks on the film after development show the location of piston ring wear and metal transfer to the cylinder walls. The amount of metal worn from the piston ring which was carried away by the lubricating oil is easily determined by placing a sample of the oil under a Geiger tube and determining the amount of radiation emitted per unit volume of oil due to the presence of tiny particles of radioactive metal from the piston ring. Studies such as this have been carried out by at least one major oil company.

These uses which have been outlined are merely a few representative samples of the many hundreds of applications of radioisotopes and should stimulate thoughts on others of value to the pulp and paper industry. However, radioisotopes should not be considered as a substitute for conventional techniques and analytical methods, but rather as a new tool for projects which were heretofore either very difficult or actually impossible to carry out. As is no doubt realized by now, there are few uses of radioisotopes which will revolutionize any industry overnight, but if used with intelligence and imagination, radioisotopes will certainly prove to be of inestimable value in the technical evolution of all industry.

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Presented at the Annual Meeting of the Technical Association of the Pulp & Paper Industry, New York, N. Y., Feb. 20–23, 1950.

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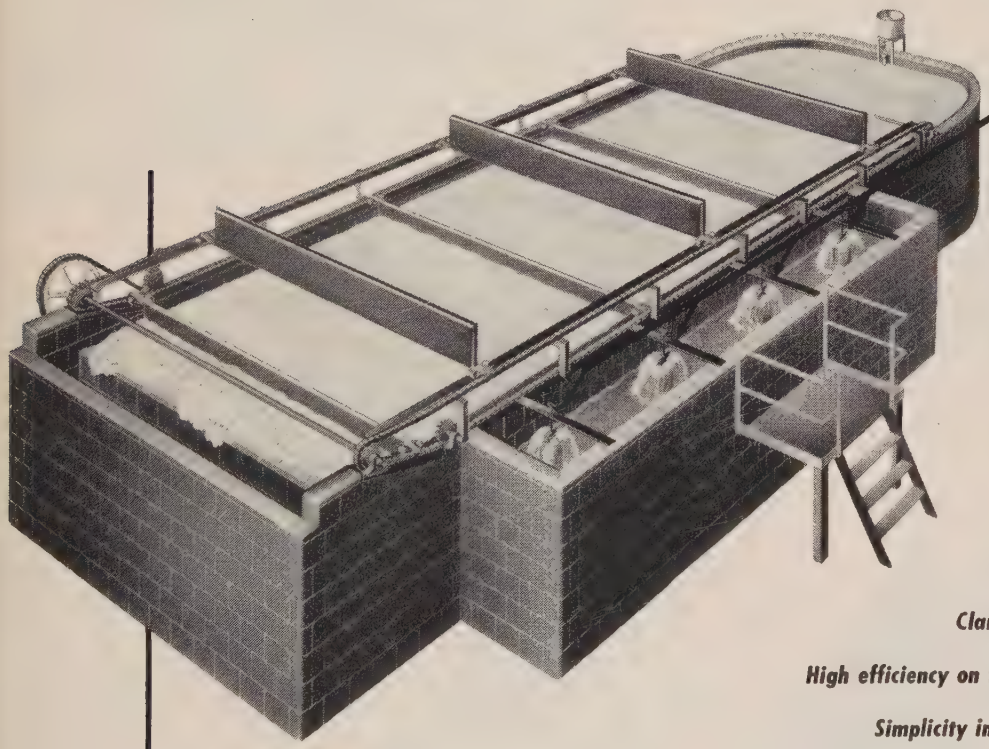

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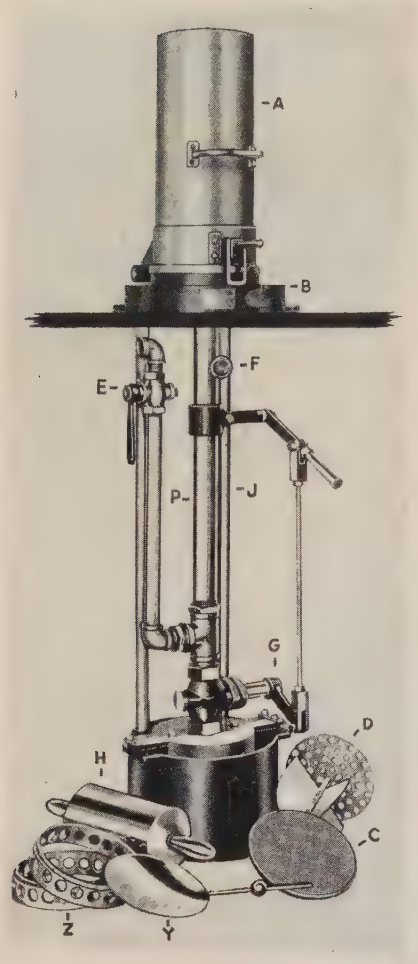

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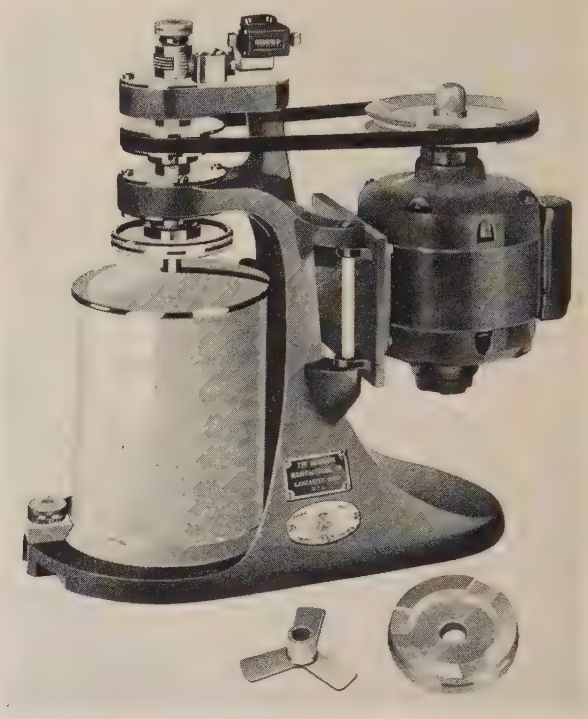
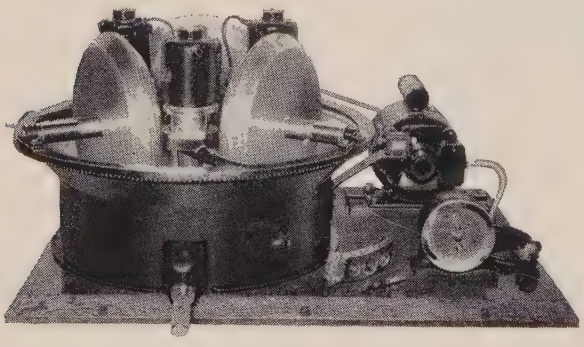


*DISINTEGRATOR



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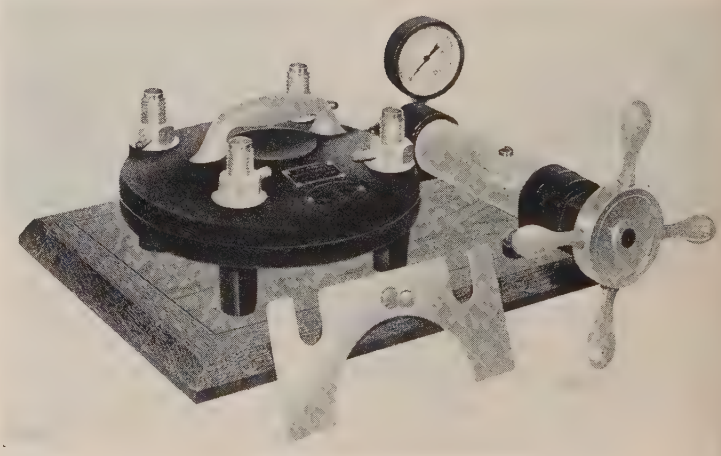

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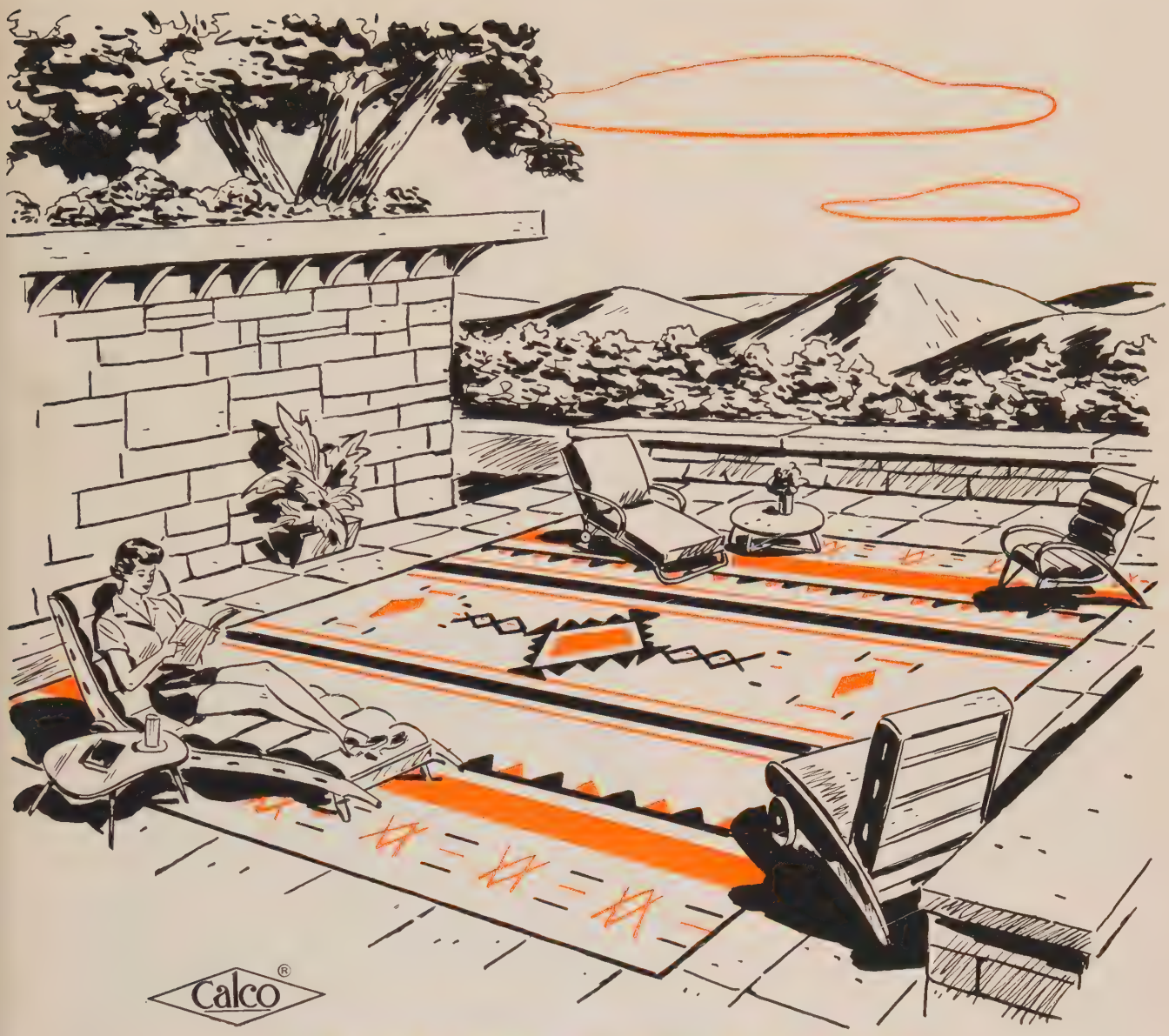

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The following principals and alternates have been appointed by the Executive Committee to serve as members of the Nominating Committee to prepare a slate of candidates to be voted on by mail ballot prior to the 1951 annual meeting of the Association:

Principals

G. W. E. Nicholson, Union Bag & Paper Corp., New York, N. Y., *Chairman*
R. H. Hurst, Kalamazoo Vegetable Parchment Co., Kalamazoo, Mich.
J. L. Parsons, Hollingsworth & Whitney Co., Waterville, Me.
C. M. Connor, W. C. Hamilton & Sons, Miquon, Pa.
R. M. True, General Dyestuff Corp., Portland, Ore.

Alternates

Stuart E. Kay, International Paper Co., New York, N. Y.
J. A. Wise, Kalamazoo Paper Co., Kalamazoo, Mich.
A. P. Gregory, St. Regis Paper Co., Bucksport, Me.
P. H. Glatfelter, P. H. Glatfelter Co., Spring Grove, Pa.
R. E. Baker, Pulp Div., Weyerhaeuser Timber Co., Longview, Wash.

The terms of the following Officers and Executive Committeemen expire in February, 1951:

President: A. E. Bachmann, Missisquoi Corp., Sheldon Springs, Vt.
Vice-President: K. P. Geohegan, Aetna Paper Co., Dayton, Ohio.
Executive Committeemen: H. W. Bialkowsky, Weyerhaeuser Timber Co., Longview, Wash.; F. C. Goodwill, St. Regis Paper Co., Kalamazoo, Mich.; R. P. Price, Hammermill Paper Co., Erie, Pa.; A. L. Sherwood, Sutherland Paper Co., Kalamazoo, Mich.

Indexes to 1949 Tappi

For the benefit of readers of *Tappi* who wish to bind their 1949 volumes of *Tappi*, reprints of the Technical Section Index and the Nontechnical Section Index have been prepared and are available on request from the Technical Association of the Pulp and Paper Industry, 122 East 42nd St., New York 17, N. Y.

Bound Volumes of Tappi 32

A number of cloth-bound copies of the Technical Section, pages 1–576 of *Tappi*, Vol. 32 (1949) are being prepared and will be sent to individuals and companies that ordered these during 1949. In addition to the copies requested about 50 extra copies are being bound and may be purchased at $5.00 per copy. Orders will be accepted by *Tappi* (122 East 42nd St., New York 17, N. Y.) for these copies while they are available.

TAPPI Standards

Early in May the 1949 mailing of TAPPI Standards was forwarded to the membership. Included with the mailing was a ballot on several standards for advancement from tentative to official standards. These included:

T 14 m-47 "Dirt in Wood Chips"
T 14 m-46 "Sieve Analysis of Pulpwood Chips"
T 475 m-47 "Bleeding Resistance of Asphalted Paper at Elevated Temperature"
T 477 m-46 "Blocking Resistance of Paper and Flexible Materials"
T 633 m-47 "Preparation of Magnesium Oxide Standard for Special Reflectance"

The Standards mailing included an index and the following methods:

E 2 p-48 "Flow Measurements of White Waters and Wastes"
E 203 p-49 "Paper Machine Drying Rate"
E 603 s-49 "Specification for Chemical Composition of Water for Manufacture of Soda and Sulphate Pulps"
O 406 p-49 "Standard Terms Used in the Sulphite Pulping Process"
T 7 p-49 "Weight-Volume Measurements of Pulpwood and Chips"
T 222 m-49 "Lignin in Wood Pulp"
T 227 m-49 "Freeness of Pulp"
T 228 m-49 "Bacteriological Examination of Pulp"
T 400 m-49 "Sampling Paper for Testing"
T 402 m-49 "Conditioning Paper and Paperboard for Testing"
T 407 m-49 "Amount of Coating on Mineral-Coated Paper"
T 414 m-49 "Internal Tearing Resistance of Paper"
T 448 m-49 "Water Vapor Permeability of Paper and Paperboard"
T 449 m-49 "Bacteriological Examination of Paper and Paperboard"
T 456 m-49 "Wet Tensile Breaking Strength of Paper and Paperboard"
T 460 m-49 "Air Resistance of Paper"
T 476 m-49 "Abrasion Loss of Paper and Paperboard"
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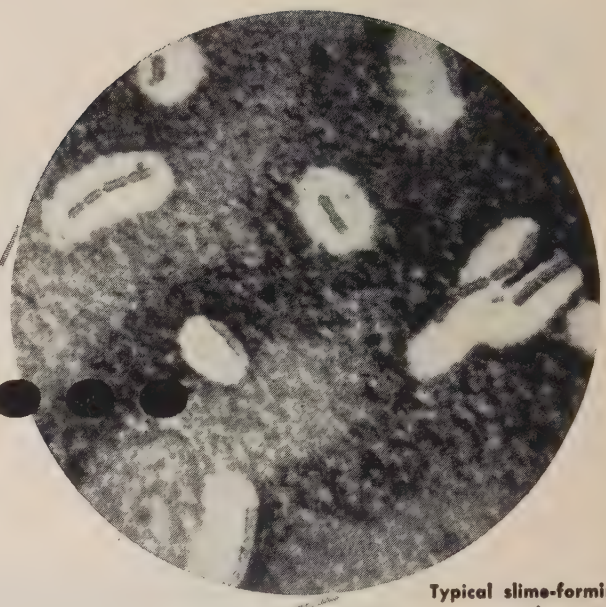

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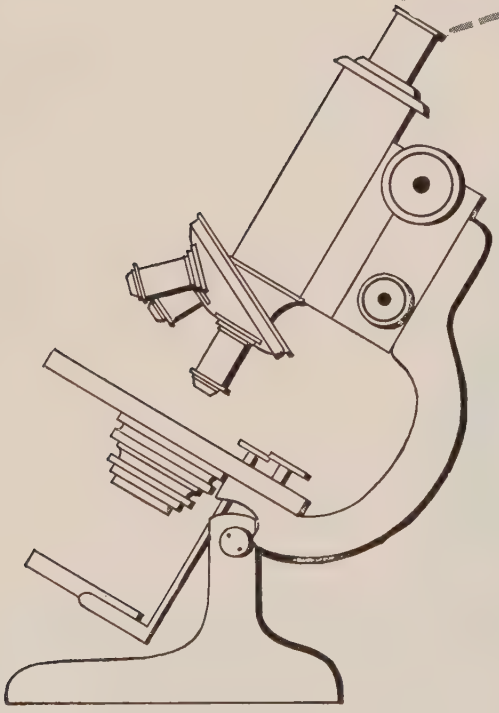

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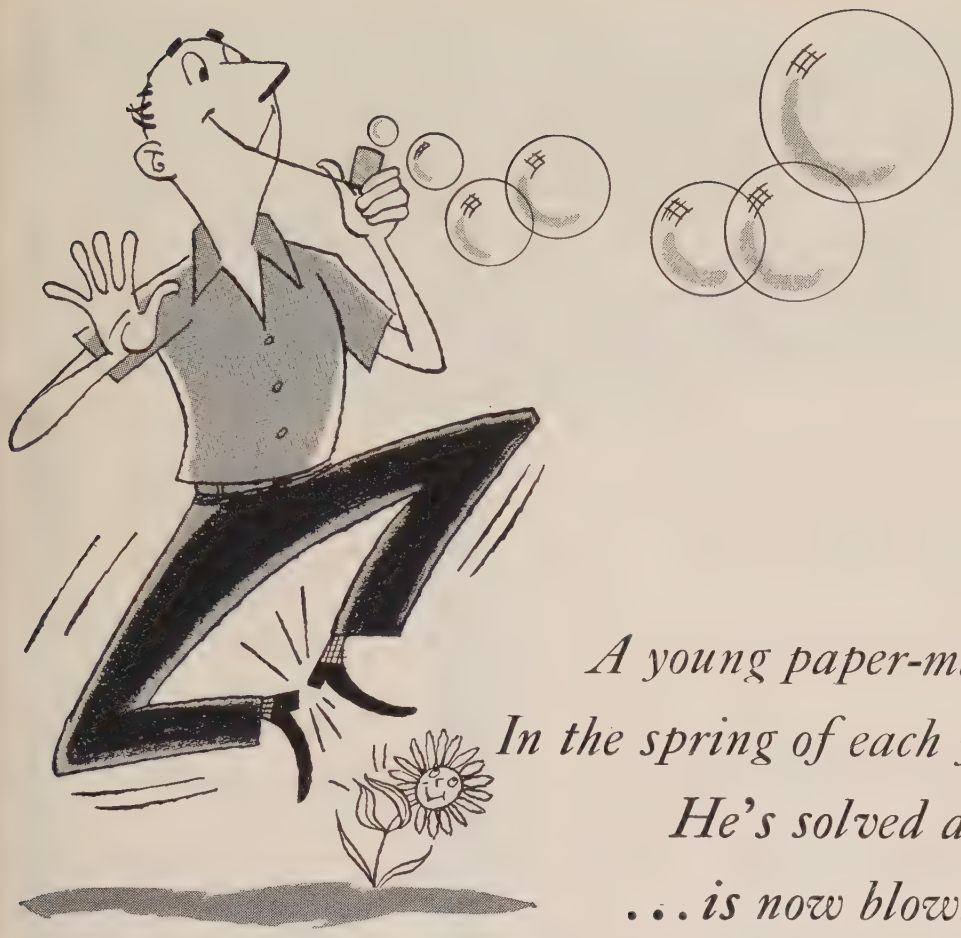

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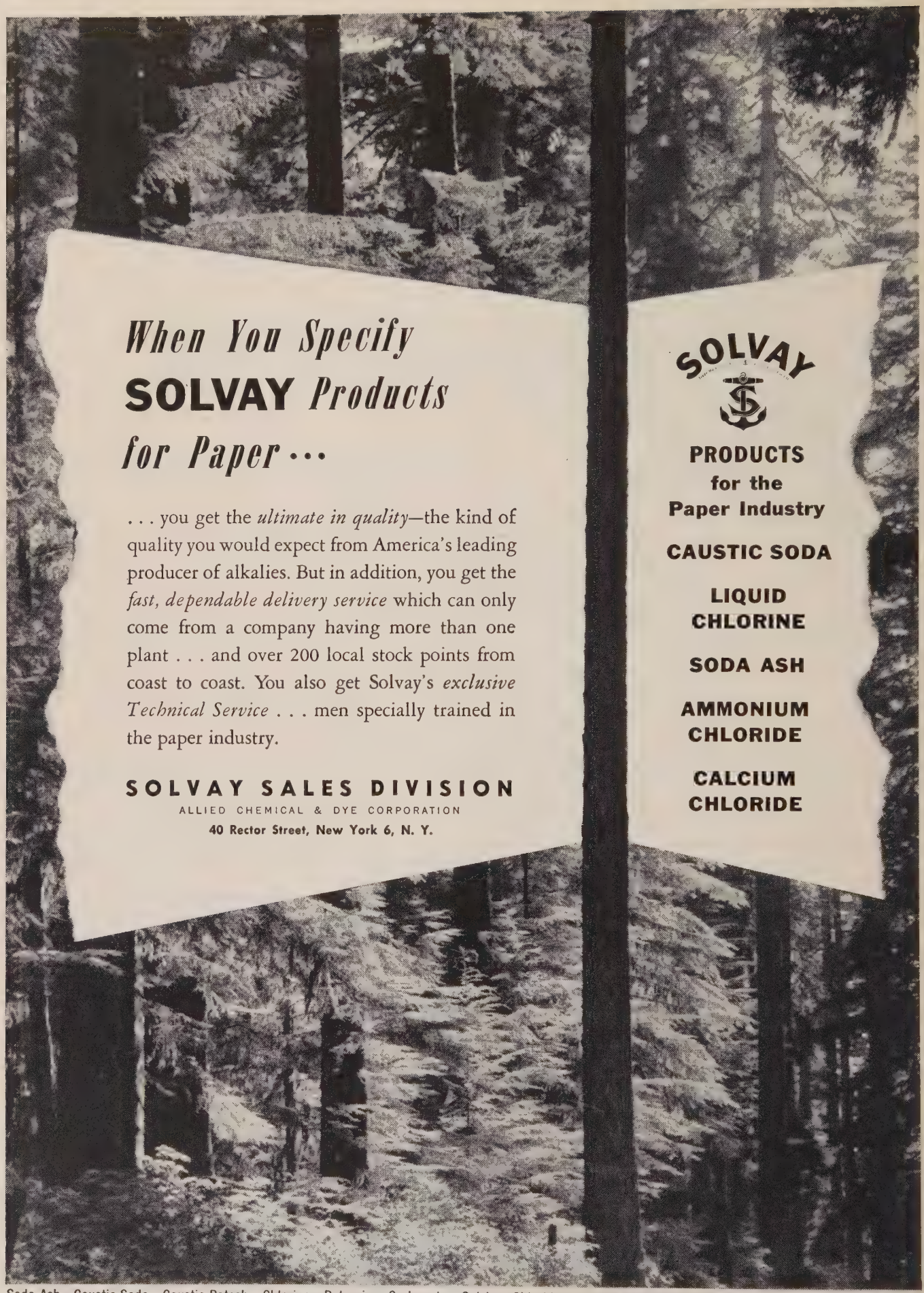
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Ammonia-Base Sulphite Pulping of Hardwoods

E. F. THODE and Y. H. LEE

The sulphite pulping of a mixture of commercially chipped birch, beech, and maple has been studied using a two-stage ammonia base process. A 1-hour steaming period, a 2-hour impregnation period, and a 2 or more hour cook constitute the digester cycle. Impregnation with 12% ammonium sulphite was carried out at 240 and 270°F. Cooking with 0.5 or 1.0% combined and about 5.2% total sulphur dioxide was accomplished at 295 to 320°F. Chemical and physical properties of the resultant pulps are contrasted with those from a long single-stage ammonia-base cook, and with results of single-stage sodium and calcium-base cooks reported by a previous investigator. The process appears comparable with a single-stage sodium-base sulphite cook and appears superior to a single-stage calcium-base cook. It is concluded that a good yield of papermaking pulp of satisfactory quality and bleachability may be obtained in a relatively rapid digester cycle using a 2-stage ammonia-base sulphite cook.

In the past fifteen years, pulp manufacturers in the northeastern part of the United States have come to realize that the increasing scarcity of softwoods desirable for sulphite pulping is coupled with and in part results from an encroachment of hardwoods in cut over softwood stands. In the opinion of many forest experts, this process, which has been going on for 75 years or more, can only be halted by increasing the amount of hardwoods used, at the same time reducing the softwood cut. In some areas the economics of pulpwood supply is now such that a given mill must pulp hardwood or shut down. To the major part of the northeastern acid pulp industry the available alternatives are to convert to alkaline or semichemical pulping or to employ the sulphite process in some manner.

Just prior to World War II, Richter (*8*, *9*, *10*) conducted an extensive investigation into the pulping characteristics of eastern hardwoods as part of a program working toward the solution of this problem. He presented a very good case for acid pulping of hardwoods. One of the high points in his paper concerns a modification of the regular sulphite process wherein the hardwood chips are impregnated with a sodium sulphite solution previous to a sulphurous acid cook. It seems unfortunate that this process did not receive wider attention at the time.

THEORETICAL BACKGROUND

It is well known that the principal reason why hardwoods do not respond as well as softwoods to sulphite pulping is that the greater density of structure of the hardwoods impedes the diffusion and imbibition of the buffer ions into the chips to a much greater degree than is the case for softwoods (*5*). In either case, it is axiomatic that the chips must be thoroughly impregnated with buffer before reaching cooking temperature lest the cellulose be degraded in localized regions of too low pH (*4*). When using conventional calcium-base cooking acid on softwood (spruce) chips this impregnation is accomplished by a gradual increase in temperature and pressure often requiring 4 or 5 hours before reaching cooking temperature. When using beech chips, however, it is common practice on the continent to devote as much as 12 hours to the impregnation (*6*) with a consequent excessively long digester cycle (16 to 19 hours) according to American standards.

From a comparison of ion mobilities, ammonium ion would be expected to diffuse more rapidly than calcium while sodium would diffuse somewhat more slowly than calcium. Previous work indicates that, contrary to their respective mobilities, calcium does not impregnate wood structure as readily as sodium; this may possibly be because of interference with imbibition of calcium ions by insoluble calcium salts. Since insoluble ammonium salts are not expected and ammonium ion has a higher mobility than calcium ion, it should be considerably easier to impregnate with ammonia base than with calcium base. If this premise be accepted, it may be inferred therefrom that a shorter impregnation period should be needed in the pulping of any wood, but particularly dense hardwoods, when using ammonia base cooking liquor as contrasted to the time required for calcium base liquor of comparable strength.

Another aspect was treated by Richter who postulated that impregnating time could be reduced if a concentrated solution of buffer were applied to the chips in a separate operation prior to actual cooking. Obviously, if exposed to a relatively concentrated solution of the buffer chemical the chips will take up the desired amount of buffer much more rapidly than when exposed to the salt in its highly diluted condition. Questions of solubility as well as diffusion speed enter in here; in the case of Richter's work, a 10% solution of sodium sulphite was settled on as being most suitable. After being impregnated with this solution at 100°C. and 100 p.s.i. gage for 4 hours, birch chips could be cooked in a 5% sulphurous acid solution in 6 hours at 135°C. (*9*).

With this information in mind, it was decided to investigate the pulping of dense hardwoods to see if the characteristics of the ammonium ion might be exploited for the purpose of achieving rapid pulping cycles.

PROCEDURE

All cooks were carried out in an indirectly heated stainless steel digester of about 2 cubic feet capacity. The digester and testing equipment used have been described elsewhere (*1*, *3*); all analyses and procedures were conducted in accordance with the appropriate TAPPI Standards (with minor variations), except that

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the Palmrose method (7) was followed in the analysis of the cooking liquor. Chips used were a commercially chipped mixture of birch, beech, and maple taken at random from the chip loft of a soda mill.

Cooking procedure for cooks involving preimpregnation was uniformly conducted as follows. Approximately 10 pounds (moisture-free weight) of chips were charged and steamed for 1 hour at about 15 p.s.i. gage pressure; after draining out the condensate from this steaming, 70 pounds of impregnation liquor (approximately 12% $(NH_4)_2SO_3$) were added and the chips impregnated at elevated temperature for 2 hours. At the end of this period the impregnating liquor was drained off and weighed, cold acid was immediately admitted, and the temperature was brought up as rapidly as possible (10 to 20 minutes) to the desired cooking level. A ratio of cooking liquor to wood of 6 to 1 was employed. Cooking was exclusively by time and temperature; excess pressure was relieved whenever necessary to keep within the 100 p.s.i. working pressure limit of the digester. Determinations of pH and chemical consumption were made periodically during the cook. Run No. 9 differed from the other cooks in that no steaming or pre-impregnation was employed, temperature rise was very slow (6 hours required to reach cooking temperature), and cooking was by pressure and sulphur dioxide content. Relief was used only sparingly and the cook was terminated (at 12 hours) at approach of exhaustion of the cooking chemical. In other words, run No. 9 was essentially a conventional sulphite cook.

At the conclusion of each cook, the digester was blown down as rapidly as possible (10 minutes), the cooked chips were washed out of the digester and transferred to a 100-gallon wooden drum. The tank was filled with water and the chips defibered by agitating with a "Lightning" mixer for about 5 minutes. The pulp was then screened through a 0.008-inch cut flat bed vibrating screen and dewatered.

RESULTS AND DISCUSSION

Cooking conditions and resultant pulp characteristics are listed in Table I. A short explanation may make this table more useful. The following quantities were deliberately varied from run to run in order to examine the process definitively: temperature of impregnation, time of cook, temperature of cook, and combined sulphur dioxide in cooking acid. In two runs an additional variable was introduced by reusing spent impregnating liquor: in run No. 3 it was refortified and reused as impregnating liquor; in run No. 6 it was used as the base for preparation of the cooking acid. All other controllable factors were supposed to be held reasonably constant and varied only accidentally. The total sulphur dioxide in the cooking acid was a factor somewhat difficult to control because of difficulties with the acid-making system; it was attempted to hold the total sulphur dioxide at about 5.1 or 5.2%, but no great significance was attached to variations from that range because of the large amount of sulphur dioxide relieved in every cook.

One of the uses in which such a sulphite hardwood pulp may be employed is the manufacture of dissolving pulp. For this reason alpha-cellulose (unbleached) is reported in two ways, based on the pulp, and based on the original wood. It may be noted that the alpha-cellulose percentage based on the original wood is but little affected by any of the variables here introduced, although run No. 4 seems to be a little better than any of the others.

It seems to make little difference whether the impregnation is conducted at 240 or 270°F., although the run giving results most nearly in line with the conventional cook employed the lower impregnation temperature.

Most of the cooks ran for 3 hours at about 313°F. As might be expected, decreasing the time of cook to 2 hours improved the yield and the physical properties and decreased the per cent alpha-cellulose. Likewise, dropping the cooking temperature 20°F. but cooking for 3 hours brought about a reduction in alpha-cellulose but resulted in improved yield and physical properties. All differences, although significant, were relatively minor. It was found, on the other hand, that an increase in cooking time was not possible under the experimental conditions employed. Run No. 8, a 4-hour

Table I. Conditions and Results of Cooks

Run number	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
Steaming temperature, °F.	260	255	252	257	255	254	255	...
Impregnating temperature, °F.	240	270	241	270	270	240	271	...
Impregnating pressure, p.s.i.	22	41	23	41	43	24	43	...
Impregnating liquor								
Initial per cent SO_2 (all combined)	6.25	6.95[a]	6.66	6.66	6.74	6.85	6.75	...
Final per cent SO_2 (all combined)	5.0	5.76	5.46	5.44	4.97	5.17	5.47	...
Initial pH	7.75	7.73	7.69	7.69	7.90	7.90	7.90	...
Final pH	7.43	6.95	7.10	6.85	7.05	6.75	7.01	...
Time of cook, hr.	3	3	3	2	3	3	4	12
Average cooking temperature, °F.	313	316	313	320	313	294	319	276[c]
Average pressure during cook, p.s.i. gage	99	98	98	99	98	78	98	91[c]
Raw cooking acid								
Free SO_2, %	4.54	4.01	4.62	4.12	4.73	4.70	4.22	4.77
Combined SO_2, %	0.92	0.96	0.48	0.99	0.49[b]	0.50	0.98	1.14
pH	1.65	1.62	1.22	1.55	1.28	1.15	1.55	1.45
Total digester time on pressure, hr.	6.5	6.5	6.5	5.5	6.5	6.5	7.5	12
Screen yield, % moisture-free	44.8	45.2	46.0	47.8	45.2	49.4	44.3[d]	44.4
Screen rejects, % moisture-free	0.7	0.7	0.7	0.9	0.9	1.8	...	0.5
Permanganate number	9.0	11.3	9.7	13.9	9.0	17.5	...	10.1
Alpha-cellulose, %	83.6	83.6	85.5	81.7	83.9	78.9	...	86.0
Maximum burst factor	39	40	39	44	39	44	...	41
Maximum tear factor	55	56	48	54	55	54	...	60
Alpha based on original wood, %	37.5	37.8	39.4	39.0	37.8	38.8	...	38.2

[a] Impregnating liquor for run No. 3 made from refortified spent impregnating liquor from previous runs.
[b] Cooking acid for run No. 6 made from fortified spent impregnating liquor from previous runs.
[c] Last 6 hours only.
[d] Total yield. Chips burned, screening and physical tests not performed.

cook, resulted in burned chips. It is thought that this was caused by loss of combined base by dissociation incident to the frequent relief of excess pressure required by this quick cooking process. It should be remembered that this phenomenon, unknown in the case of all other bases in common use, is quite possible where ammonia base is used and is very likely to occur where relieving is frequent or excessive.

There seems to be no advantage to very low combined sulphur dioxide in the cooking acid as far as the results are concerned. Of greater practical importance is the fact that higher combined is unnecessary because of the ammonium sulphite retained by the chips.

PRACTICAL CONSIDERATIONS

Whether or not this process would be of commercial interest would depend on a number of factors which should be more thoroughly investigated if mill application is contemplated. An attempt was made in this investigation to touch on some of these factors, although limitations of time precluded all but a cursory survey.

Chemical utilization, as contrasted with a conventional cook, is perhaps the most important economic factor which needs further study. In every cook, a great deal of relieving was necessary; if the acid-making system is designed to carry such a load, this particular effect need not affect the chemical economy, in that, presumably, all the relieved sulphur dioxide may be recovered and reused. A more important consideration is the impregnating liquor; because of the high concentration of chemicals on this liquor, these chemicals must be reusable or recoverable at low cost. In runs Nos. 3 and 6, reuse of the impregnating liquor was tried. In run No. 3, the spent impregnating liquor from two previous runs was refortified and reused, while in run No. 6, the spent impregnating liquor from a previous run was used as the base for the cooking acid. No significant differences in results were observed. This indicates that impregnation liquor may be used over at least once, but it does not establish how many times such liquor may be so reused before the concentration of sugars and other organic materials would interfere with the completion of a desirable cook. Figures on the retention of impregnating liquor by the chips were not very consistent, but on an average, about one half pound of liquor per pound of chips was retained. (This figure is about the same as reported by Richter on Na_2SO_3 liquor.) It was not possible to study the amount of impregnating liquor actually required to obtain the desired results; it is probable that further investigation will show that the amount here used may be drastically reduced.

Assuming that eventually the impregnating liquor will have an undesirably high concentration of organics upon repeated reuse and that use as a base for makeup of cooking acid will not serve as an outlet for all such liquor produced, the fact that ammonia base is here used raises the possibility of chemical recovery from such spent liquor. A discussion of such possibility, however, must await publication of results of various investigations being conducted on the recovery of chemicals from ammonia-base sulphite waste liquor.

It should be noted that in the earlier investigation previously referred to (*9*), the impregnation was accomplished at a lower temperature (212°F.) but a higher pressure (100 p.s.i.) by treating the chips with the chemical solution in a vessel under pressure of an inert gas. Presumably the liquor drained off the chips under such conditions would have a rather low content of soluble organics and might be reused almost indefinitely. Two factors must be considered in contrasting this process with the one here reported: first, the impregnation in the present work serves also as a sort of semichemical precook and thus probably reduces the time required for the actual cook; second, the inert-gas impregnation may encounter serious obstacles in being reduced to commercial practice.

COMPARISON WITH PREVIOUS WORK

A comparison with single-stage hardwood sulphite cooking results previously published (*9*) may be of interest. In Table II, the results of selected experiments from this investigation and from the work of Richter are compared. It should be noted that his mixed hardwood chips contained less of the short fibered maple than did the chips used in the present work, which contained about 34% maple, the rest mostly birch. Likewise, it should be emphasized that the runs designated A (pure maple) and B (mixed hardwoods) were made with selected laboratory prepared chips; whereas mill prepared chips were used in all the other runs in this table. As demonstrated by Richter, chip dimensions are of extreme importance in the pulping of hardwoods so that both yield and physical properties of pulp from mill chips would be expected to be poorer than those of pulp from selected laboratory chips of the proper dimensions.

In surveying the data of Table II it may be seen that the process here reported has a slight advantage in yield, in bursting strength, and in time and a slight disadvantage in tearing strength as contrasted with the single-stage sodium-base sulphite process. The advantages over a calcium-base single-stage cook are pronounced. It should be pointed out that Richter was able to obtain a yield of 49% with very good physical

Table II. Comparison of Results on Mixed Hardwoods

Run number[a]	*4*	*5*	*7*	*9*	*A*	*B*	*C*[1]	*C*[2]	*C*[3]
Base	NH_3	NH_3	NH_3	NH_3	Na	Na	Na	Ca	Ca
Total digester time, hr.	6.5	5.5	6.5	12	8	8	8	8	10
Time at cooking temperature, hr.	3	2	3	6	3	4	4	4	5
Cooking temperature, °F.	313	320	294	276	284	284	284	284	284
Yield, %	46.0	47.3	49.4	44.4	44.9	44.0	43.0	36.0	41.0
Screenings, %	0.7	0.9	1.8	0.5	1.9	1.2	0.6	9.0	3.5
Burst factor	39	44	44	41	38	41	40	33	34
Tear factor	48	54	54	60	59	69	70	55	72

[a] Run Nos. 4, 5, 7, and 9 correspond to numbers used in this investigation, further data on which are presented in Table I. Runs designated A, B, C^1, C^2, and C^3 are taken from the data of Richter (*9*). All of these cooks were made with a bisulphite cooking acid containing 5% free and 1% combined SO_2 with the base as indicated. In run A, laboratory prepared rock maple chips were used; run B employed laboratory prepared mixed hardwood chips (approximately equal proportions of white birch, yellow birch, beech, and maple); while in the runs designated C^1, C^2, and C^3, mill prepared mixed hardwood chips of like proportions were used.

Table III. Bleaching Results

Run No.	Hunter brightness Initial	Hunter brightness Final	Bleaching yield, %	Final alpha-cellulose, %
4	55.4	86.8	90.4	87.2
5	54.5	86.0	85.2	88.0
9	54.4	85.3	84.0	90.2

properties on laboratory prepared mixed hardwood chips in an 8-hour cook employing a sodium-base liquor containing 5% and 2% combined sulphur dioxide.

BLEACHING

Samples of pulp from runs 4, 5, and 9 were bleached according to the following procedure, modified from one recommended in the literature (*10*) as being particularly effective for hardwood sulphite pulps:

First stage: hypochlorite: 4% NaOCl by weight on moisture-free pulp, consistency 8%, pH 8.5, 4 hours at 20°C.
Second stage: caustic extraction: 12% NaOH and 1% turkey red oil, consistency 6%, 4 hours at 75°C.
Third stage: chlorination: 0.6–1.2% Cl_2; consistency 6%, pH 2, 1 hour at 20°C.
Fourth stage: hypochlorite: 2% NaOCl, consistency 8%, pH 9–11, 4 hours at 35°C.

Results are tabulated in Table III.

Bleaching results show an encouraging brightness figure but the yield and alpha-cellulose are lower than would be desirable for chemical dissolving pulp. According to Farber (*2*), the customary over-all yield on beech nitrating pulp on the continent is around 36%. If such a figure be acceptable, it would seem that about the same yield of a high alpha product might be obtained from one of these pulps, given an adequate purification.

CONCLUSIONS

It is concluded that a good yield of papermaking pulp of satisfactory quality and bleachability may be obtained in a relatively rapid digester cycle, using a two-stage ammonia-base sulphite cook.

This process appears to be comparable in results with a single-stage sodium-base sulphite cook and appears superior to a single-stage calcium-base process.

It is thought that the relatively high mobility of the ammonium ion and the ready solubility of ammonium salts may be responsible for the apparent advantages of this process.

Possible commercial attractiveness of this two-stage process would depend on various economic factors connected with utilization of chemicals; further work on the pulping variables and chemical consumption is suggested.

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Received Dec. 20, 1949. Presented at the Annual Meeting of the Technical Association of the Pulp & Paper Industry, New York, N. Y., Feb. 20-23, 1950.

This paper constitutes part of a thesis submitted by Yih-hung Lee to the Graduate Faculty of the University of Maine in partial fulfillment of the requirements for the degree of Master of Science in Chemical Engineering (Pulp and Paper Division), Jan., 1950.

The authors wish to thank Professor Lyle C. Jenness for his many helpful comments and suggestions during the course of this investigation. The helpfulness of the Penobscot Chemical Fibre Co. in donating the chips used in the experimental work is much appreciated.

Salinity of Salt Water-Borne Wood

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In a closed sulphite process the accumulation of inorganic salts may present an operating problem. Logs transported in salt water pick up a considerable quanitiy of salt. The object of this investigation was to determine the amount of inorganic salt introduced into the pulping system at the Everett pulp mill of the Weyerhaeuser Timber Co. Approximately 73% of the chips used were produced from salt water-borne logs. It was found that for each ton of air-dry chips charged to the digester, 5.1 pounds of salt were introduced to the pulping process. This is an average value and large variations in salt content do occur in the wood supply.

The problem was to determine the salt content of the wood supply for the Everett mill of the Pulp Division of the Weyerhaeuser Timber Co., since about 73% of the wood used comes from salt water-borne wood. Salinity tests show that about 3440 pounds of salts are picked up from the sea water and transferred to the digesters when 675 air-dry tons of chips are cooked. This is a normal 24-hour usage. In other words there are about 5.1 pounds of salt from each air-dry ton of chips.

The following will describe the history, procedure, and data used to determine the aforementioned salt content of the wood supply.

Redfield (*1*) states that the proportions of the major constituents of natural sea water are very uniform, the ratio of water to total salt content being the principal variant. Therefore the quantity of any constituent may be estimated if the chlorinity of a sample is measured.

A survey of water conditions in Port Gardner Bay, made jointly by the Soundview Pulp Co. and the Everett Pulp Division of the Weyerhaeuser Timber Co., showed that the chlorinity of the waters of Puget Sound adjacent to Everett runs about 15 parts per thousand. Using this as a base it is possible to calculate from chlorinity charts the make-up of water adjacent to

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Everett as presented in Table I. If the equivalent of cations and anions are converted to grams of material, the salt content of the sea water is about 2.74%. This figure is the total salt content, or salinity, of the water and corresponds to a chlorinity of 15 parts per thousand.

Definitions of chlorinity and salinity as given by Redfield may be in order. Salinity is the total amount of solid material in grams contained in 1 kg. of sea water when all the carbonate has been converted to oxide, the bromine and iodine replaced by chlorine,

Table I. The Major Constituents of Sea Water Adjacent to Everett

Ion	*Equivalents per million*	*Parts per thousand*
Chlorinity = 15 parts per thousand		
Sodium, Na	362.3	8.3
Magnesium, Mg	82.6	1.0
Calcium, Ca	15.8	0.3
Potassium, K	7.7	0.3
Total	468.4	9.9
Chloride, Cl	422.5	15.0
Sulphate, SO_4	43.5	2.1
Bicarbonate, HCO_3	1.8	0.1
Bromine, B	0.6	0.0
Total	468.4	17.2

and all organic matter completely oxidized. Chlorinity is the total amount of chlorine in grams contained in 1 kilogram of sea water assuming that the bromine and iodine have been replaced by chlorine. Salinity is related to chlorinity as follows:

$$\text{Salinity} = 0.03 + (1.805 \times \text{chlorinity})$$

If it is assumed that all of the water in the chips was replaced by sea water, it would be approximately 50% of the weight of the wood and about 27 pounds of salt would be present per ton of air-dry chips. This would amount to 18,225 pounds of salt per day at the mill.

It was found that the actual salt content of chips never approached this high a figure. Daily tests were made over a 1-month period on chips going to the chip storage bins. The maximum amount of salt per air-dry ton of chips over this period was 13 pounds. The minimum amount was 0.9 pounds and the monthly average was 5.1 pounds. Using this average figure for salt and 675 air-dry tons of chips per day, 3440 pounds of salt could be realized from sea water during 1 day's operations.

Considering the definition of salinity and chlorinity, of the 3440 pounds of salt, 3090 pounds would be sodium chloride. This is not strictly true since the determination was made of chlorides and some of the chlorides are present as salts of potassium and magnesium. We have no knowledge, furthermore, as to reactions the metallic ions in wood itself will follow—or how they may affect the above balance—especially under combustion conditions.

Naturally occurring salts in the wood are not present as chlorides since tests showed that wood which had not been in salt water had no measurable chlorinity. However, it was known that wood is a source of inorganic salts, the ash content varying between 0.2 to 0.3%. Table II shows an approximate analysis of wood ashes.

Using this analysis and assuming an average ash of 0.25% for wood as grown, 675 air-dry tons of chips would contribute 3035 pounds of metallic ash as oxides. Of this amount, about 540 pounds of oxide could be attributed to potassium and sodium.

Salt concentrations are not uniform throughout the supply of wood as illustrated in Table III.

The method devised to determine the chlorinity of woody samples consisted of a cold water extraction. A Waring Blendor aided very much in this operation, completely pulping the wood. The extract was titrated with standard silver nitrate solution using potassium chromate indicator.

Table II. An Approximate Analysis of Wood Ashes, %

CaO	70
K_2O	15
MgO	10
P_2O_5	2
Na_2O	1
Fe_2O_3	1
Mn_3O_4	0.5
Al_2O_3	0.5
Total	100.0

Chlorides, sulphates, and silicates are found only in trace amounts (*2*) (*3*)

Although the method described seems very simple, many other methods were tried and found wanting. On ashing a wood sample, results are dependent on time and temperature, and results vary accordingly. A hot water extraction takes out tannins, waxes, and other colored organic material which interfere with a titration. The most reproducible results were obtained with the cold water method.

Table III. Salt in Wood Supply

Sample		*Parts per thousand parts chlorinity*	*Air-dry sample salinity*
Daily chip analysis over 1-month period[a]	Maximum	3.58	6.50
	Average	1.39	2.55
	Minimum	0.24	0.45
Sawdust			
Large log cut-off saw		3.44	6.24
Band saw		2.35	4.27
Small log cut-off saw		2.24	4.07
Farm wood		Trace	Trace
Pulp		No trace	No trace

[a] During the period covering the above tests 73% of the wood used to produce chips was transported in salt water. The remaining 27% of the wood came from farm logs, slabs, and clear wood which had not been in salt water.

An interesting aspect of the salt problem is distribution in the cooking system. It was difficult to determine the chloride in cooking acid, however, it was found that an alkaline permanganate oxidation would clarify the solution enough to run a regular titration. Although the results presented in Table IV are not conclusive, they may be considered an indication of the amount of salt to be expected. It is believed that the application of instrumental analysis such as the dropping mercury electrode polarograph or the spectrograph could probably give more precise values.

Table IV. Salinity of Various Liquors

Sample	*Parts per thousand parts solution* Chlorinity	Salinity
Cooking acid	0.116	0.239
Storage acid	0.031	0.086
Low-pressure accumulator acid	0.025	0.075
Blow Liquor	0.291	0.555

An average value of 0.555 parts salinity per thousand parts of blowdown waste was found. If a normal value of 40,000 gallons waste liquor per blow is assumed, the salt content in the waste liquor per day is 3330 pounds. This value obtained from the analysis of normal mill liquor checks very closely with the value of 3440 pounds of salt per day obtained from analysis of the incoming chips.

In conclusion, for each air-dry ton of chips approximately 5.1 pounds of salt are taken into the mill. In a closed system, such as magnesium base, this salt must be considered for it could build up to a dangerous level and cause trouble at various points of the operation, such as boilers, recovery system, and cooking process.

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Received April 20, 1950. The Shibley award paper presented at the meeting of the Pacific Section of the Technical Association of the Pulp & Paper Industry, Camas, Wash., April 7, 1950.

Use of a Roll-Type Fiber Press on Straw

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A short description of the action and the results obtained on straw with a roll-type fiber press.

The fiber press consists of three rolls, a top roll superimposed over two bottom rolls and having contact with each. The top roll operates under a predetermined constant pressure from 0 to 165 tons depending on the size of the unit and the material being processed. Because of the positioning of the rolls, material introduced into the process is acted upon twice: first, by the top roll and front roll, and again, by the top roll and back roll. The equipment is massive in design as the pressures exerted by the top roll against the material being processed are high. The roll shells, of special ferrous alloy, are mounted on steel shafts and have a particular grooved configuration, the result of long years of experience and tests in extracting liquor and reducing fibrous materials. Below the rolls is a trough, which is an integral part of the foundation and bed frames, to catch the expressed liquors.

A small unit, with rolls 23 inches in diameter by 36 inches long, is operated by a 50 to 60-hp. motor depending on the material being processed. A larger unit (rolls 24 inches in diameter by 54 inches long) is operated by a 100-hp. motor. The motor is directly coupled with a speed reducer which drives the gearing necessary for operation.

At the suggestion of one of the strawboard mills investigation was started on the possibility of using the roll press for cutting raw straw in both a wet and dry condition. From several tests, it was determined that the machine operated in an equivalent manner on straw partially rotted, on straw which had been frozen, on freshly baled straw, or on straw which had been ricked for some time.

The first tests were made with the smaller unit on dry straw. The wires were removed from the bales, the wafers opened up, and the straw passed through the press. As it was found that under 90 to 100 tons top roll pressure a considerable amount of the material processed was below 2 inches in length, it was decided that wetted straw should be tried since the moisture might reduce friction and create some slippage of the particles between the rolls. An ordinary garden hose spray nozzle, set for a medium fine spray, was positioned over the straw as it passed into the feed hopper of the press. This method, with wetted straw, proved to be more successful in that it reduced the amount of fines to a great degree. After several more tests were run and various roll spacing adjustments were made, it was determined that the ideal condition for cutting raw straw in either a wet or dry state was a comparatively low tonnage on the top roll. A roll spacing was established which is now considered most desirable.

The summation of the results of the composite tests thus far made in cutting raw straw, and the data secured from actual length count on a large amount cut for a 9-point board mill are as follows:

8 inches long or over	3.5%
7 inches long or over	3.6
6 inches long or over	4.0
5 inches long or over	3.3
4 inches long or over	5.9
3 inches long or over	24.7
2 inches long or over	54.2
	99.2%

Note that the sum of 2 and 3-inch lengths is 78.9% of the total.

On an actual test with a 14-foot diameter rotary cooker, over 10,000 pounds of straw cut by the press were placed in the digester in a single fill. The reason for the added capacity is undoubtedly due to the fact that the press flattens the straw in cutting it, thus delivering the straw with a smaller mass volume per unit length than exists in round straw. It was also noted that the majority of nodes and rachises were cracked and broken, allowing for faster penetration of cooking chemical. It is the general opinion of many pulpmakers that the ability to cut raw straw in a wet condition opens the possibility for preimbibing the straw with some of the cooking chemical prior to filling the digesters. The filling and emptying of the digesters is very rapid—a matter of minutes.

Other applications are the initial mild defibering, cutting, and dewatering of straw pulp and various other pulps taken directly from the digesters. This

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application, now in actual use in production, can be subdivided into two resultants:

Cooked straw pulp introduced into the press is discharged in a desirable condition for refining. Some of the whole straw has been separated by the wringing action of the press so that a major portion has been split away in fibrous pieces, longitudinally or lengthwise. Most of the nodes and rachises are mashed or split and only rarely occur in a whole state. The long-tangled fibers from the whole straw are separated and disentangled by the cutting action of the press. The necessity for breaker beating is thus completely eliminated. The pulp comes from the press in an even homogeneous blanket, and when this pulp is re-wetted, it disintegrates into shorter pieces which can be distributed through the mill by pumps.

2. The dewatering action of the press removes the major portion of the black liquor in the straw without dilution resulting in reduction of wash water requirements. Where stream pollution is a problem, and this problem is a universal one, the first logical step in combating stream pollution is the reduction of the volume or mass of material to be handled, whether it be treated by a disposal process, lagooned, or discharged to sewers. The following data are from test runs on a 23 inch diameter by 36 inch long roll size production unit set up expressly for this work.

	Before Fulton press		*After Fulton press*	
	Consistency, %	*Water, %*	*Consistency, %*	*Water, %*
Straw pulp directly from digesters	12.7	87.3	49.4	50.6
Flax pulp directly from digesters	17.0	83.0	52.0	48.0
Tropical grass pulp directly from digesters	31.1	68.9	48.5	51.5
Wood kraft knots, screenings and rejects	16.2	83.8	52.3	47.7
Wood mill refuse—scrap and bark	Undetermined		54.7	45.3
Bark from Northeastern woods	Undetermined		54.1	45.9
Kraft jute pulp	13.2	86.8	48.6	51.4

The amount of fiber discharged with the expressed liquor is negligible and can be easily reclaimed, if desired, by a common hillside screen.

A recognized commercial laboratory has determined that straw pulp processed by the fiber press produced sheets having improved qualities in tear and bursting strength tests.

Received Dec. 30, 1949. Presented at the meeting of the TAPPI Fibrous Agricultural Residues Committee, Terre Haute, Ind., Nov. 7–8, 1949.

The Oxidation of Sulphite Waste Liquor Lignin to Aromatic Organic Chemicals

IRWIN A. PEARL

More than sixty years ago a German patent was issued to A. S. Nettl (*1*) for the oxidation of sulphite waste liquor to oxalic acid by fusion with mixed caustic soda and potash. Since that time hundreds of papers have been published and many patents have been granted on various methods of oxidation of lignosulphonate materials to aliphatic organic compounds, such as oxalic, acetic, and formic acids and to aromatic organic compounds, such as vanillin, protocatechuic acid, and the like. Some of these have been purely empirical in nature with yields of produced chemicals as the only goal. Others have been fundamental in character with the mechanism of the reaction being the objective. Still others are a mixture of empirical methods and experiments combined with theoretical discussions of the fundamental aspects of the experimental data. The present paper will consider all three types of studies but will be limited to those directed in the main to the production of aromatic organic compounds.

As early as 1898, Pollacsek (*2*) received an Austrian patent on a process for producing vanillin by the oxidation of sulphite waste liquor with air and ferric chloride. A few years later (1904), Grafe heated a mixture of sulphite waste liquor solids and lime at 180°C. in a sealed tube, leached the reaction product with water, removed the lime by precipitation with carbon dioxide, and extracted the solution with ether. The ether extract yielded a small quantity of vanillin. For almost a quarter of a century this discovery remained unnoticed until, in 1928, two investigations revived interest in the production of vanillin from lignin sources. Pauly and Feuerstein (*3*) described a process for the oxidation to vanillin of lignin in such materials as mosses, grasses, straw, esparto, hemp, flax, jute, ramie, wood, peat, lignite, brown coal, lyes containing lignin, and separated constituents such as phenol lignin and lignosulphonic acid. Temperature below 90° and oxidizing agents such as ozone, chromic acid, and sulphanilic acid in the presence of acetic acid were employed. Yields as high as 6% on the lignin basis were noted. In the same year, Kürschner (*4*) published his observations on the formation of vanillin from sulphite waste liquor by heating with alkali metal hydroxides under varying conditions. Variables studied were concentrations, reactant ratios, temperature, and reaction time and introduction of air. Kürschner acidified the alkaline reaction mixture and extracted the liberated vanillin with an immiscible solvent to give yields of from 5 to 10% on the lignin basis. During the course of the following years many articles were published on modifications of Kürschner's process (*5–9*) and in 1936 Tomlinson and Hibbert (*10*) reported a systematic study of the reaction in which they demonstrated that a maximum yield of 7.0% (on the lignin basis) of vanillin could be obtained by the "alkaline hydrolysis" of sulphite waste liquor. Furthermore, these authors

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found that the yield of vanillin increased with increased sulphonation. Hägglund and co-workers (*11–12*) confirmed these results. It should be noted that, in all these studies, the vanillin was not isolated, but was determined gravimetrically by precipitating with an agent such as *m*-nitrobenzhydrazide. Unfortunately, this agent will precipitate other similar materials and reported results are probably somewhat high.

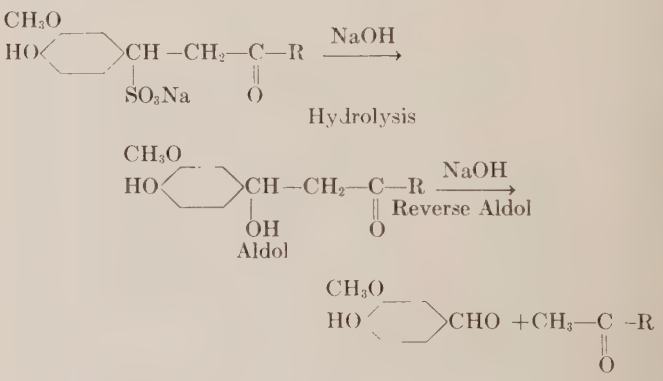
The thousands of tons of sulphite waste liquor discarded by the sulphite pulp mills of the world offered an unlimited source of vanillin by the improved "alkaline-hydrolysis" process. However, the need for concentrating huge amounts of dilute liquors, the costly chemical consumption by the carbohydrate fraction of sulphite waste liquor, and the technical difficulties involved in the extraction of vanillin from the acidified reaction mixtures made the process commercially unfeasible.

These difficulties were obviated by the Marathon-Howard processes (*13, 14*). In accordance with Howard (*13*) the dilute sulphite waste liquor is fractionally precipitated with caustic lime, and the lignin is isolated as a basic calcium lignosulphonate free from nonlignin materials. This carbohydrate-free lignosulphonate is digested under pressure at 160°C. with a strong caustic soda solution, thus transforming a part (2 to 3% on the lignin basis) of the lignin to vanillin. The latter, as its sodium salt, is extracted directly from the alkaline reaction mixture by means of butanol (*14*). The butanol extract containing the sodium salt of vanillin, together with minor amounts of the sodium salts of other phenolic materials, is distilled to recover the butanol. The final traces of butanol are removed by azeotropic distillation with water. The residual water solution of sodium salts is acidified with sulphur dioxide. This precipitates the undesirable phenolic bodies (essentially crude acetovanillone) and leaves in solution the vanillin as its sodium bisulphite addition product. The mixture is filtered, and the filtrate is further acidified with sulphuric acid to liberate the vanillin from its addition compound. After the sulphur dioxide is expelled, the crude vanillin which separates is filtered and purified by high vacuum distillation, followed by recrystallization from water. The vanillin thus obtained is chemically pure.

In 1937, the Salvo Chemical Corporation began the commercial manufacture of vanillin by the above process in its plant erected at Rothschild, Wisconsin adjacent to the Marathon pulp mill. It was not long before this plant was supplying about two fifths of this country's vanillin requirements. The raw material available to the Salvo plant from the Marathon mill at Rothschild alone was sufficient to meet the present vanillin requirement of the entire world. At this point it may be pointed out that the low yield of 2 to 3% vanillin on the lignin basis is not due entirely to inadequacies of the process. Inasmuch as the caustic soda is the most expensive raw material employed in the process, the reaction conditions have been modified to give the highest yield on the basis of the caustic soda rather than on the lignin basis. Incidentally, in the last few years, the commercial operation at Rothschild has been modified in accordance with the process outlined by Salvesen, Brink, Diddams, and Orozarski (*15*) by introducing gaseous oxygen under pressure, thereby increasing the yield of vanillin by as much as 82%.

An entirely different process, developed by Hibbert and Tomlinson (*16*), was placed in operation at about the same time by Howard Smith Chemicals, Ltd., at the sulphite pulp mill in Cornwall, Ontario. In this process, the sulphite waste liquor is first concentrated and then treated with a large excess of caustic soda at an elevated temperature and pressure. The resultant solution is acidified by means of carbon dioxide (stack gases) and the solids removed. The clarified liquor is then extracted countercurrently with benzene, and the caustic in the vanillin-free liquor is regenerated by incineration and causticization, with the incidental recovery of steam. The benzene solution is then concentrated by evaporation, and the vanillin removed by means of sodium bisulphite. The purification steps are essentially those employed by Salvo. In addition to supplying most of Canada's vanillin requirements, Howard Smith Chemicals, Ltd. ships substantial amounts to the United Kingdom.

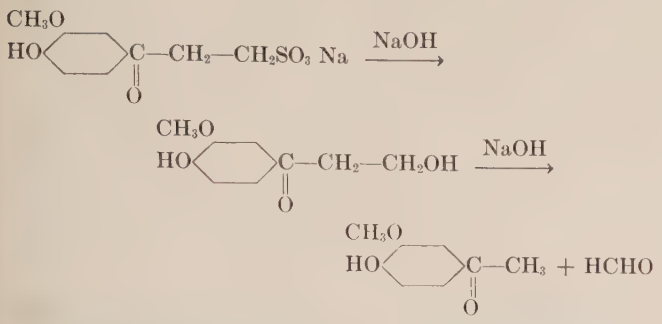
Until about 1940, it was a generally accepted fact among lignin chemists (*10–12, 17*) that only in the form of its sulphonate would lignin yield vanillin upon alkaline hydrolysis or mild oxidative treatment. This was true in spite of the above noted disclosure by Pauly and Feuerstein (*3*) that vanillin was produced by mild oxidation of lignin in all its forms. In fact Tomlinson and Hibbert (*17*) in 1936 proposed a mechanism for the formation of vanillin in which it was assumed that the lignin was sulphonated on the carbon atom adjacent to the vanillin nucleus, and the sulphonate was then hydrolyzed to the corresponding hydroxylated compound which would then undergo a "reverse aldol" reaction to yield vanillin. For example:



This mechanism for vanillin formation was supported by Kratzl and co-workers (*18, 19*) who treated model substances with alkali in an atmosphere of nitrogen and found that only those sulphonic acids which are capable of forming "aldol type" compounds upon hydrolysis yielded vanillin. Since these model reactions were performed in the absence of oxygen, these authors concluded that the process cannot be one of oxidation, and that the reaction mechanism of vanillin formation from sulphite waste liquor must be of a different nature.

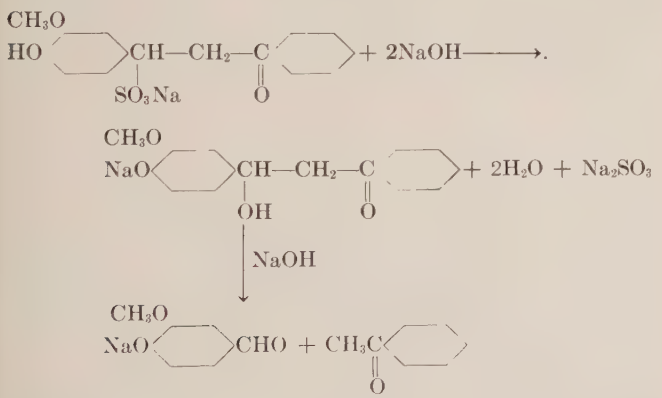
Kratzl and Rettenbacher (*20, 21*) have demonstrated that acetaldehyde, which heretofore had not been observed, is actually formed when model substances in which R in the above formulas is H or even when lignosulphonate itself is heated in alkaline solution. The finding by Hibbert and co-workers (*22, 23*) of acetovanillone in lignosulphonate-alkali reaction mixtures and the isolation of approximately 100 pounds per day

of acetovanillone at the Salvo vanillin plant could be explained by this mechanism by assuming a configuration for part of the lignosulphone complex similar to the following:



Formaldehyde, the other product of this reaction, has recently been isolated by Kratzl (*24*).

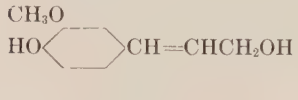
In our laboratories we have believed for many years that even the so-called "alkaline" hydrolysis of lignosulphonic acid is an oxidation reaction in which the sulphonic acid group is the oxidizing agent. This belief is based on the facts that, in any alkaline hydrolysis of a lignosulphonate, considerable sulphur dioxide is liberated when the alkaline reaction mixture is acidified and that the yield of vanillin increased with increased sulphonation. This idea was suggested two years ago at a lignin symposium by Brauns (*25*, *26*), but Tomlinson disagreed (*26*). Tomlinson reiterated his theory of the reverse aldol mechanism and cited as evidence the results obtained with the model substance prepared by sulphonating 3-methoxy-4-hydroxybenzylideneacetophenone.



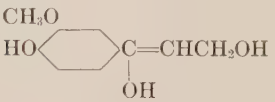
Tomlinson noted that the sulphonic acid group was split off as sodium sulphite.

This experiment is evidence in favor of the "reverse aldol" mechanism but, in addition, it supports the oxidation hypothesis which, by the way, is in no manner opposed to the "reverse aldol" mechanism. In this instance the "alkaline hydrolysis" must have been accompanied by oxidation of the organic moiety because reduction of the sulphur in the sulphonic acid necessitates oxidation of the organic portion.

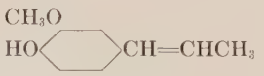
The earlier work of Pauly and Feuerstein took on new significance when Schulz (*27*) and Freudenberg, Lautsch, and Engler (*28*) demonstrated that yields of vanillin up to 25% on the lignin basis could be obtained by mild oxidation of sulphite waste liquor with nitrobenzene and alkali under pressure. These investigators found that not only lignosulphonates but all lignin preparations and even wood flour were amenable to this reaction. In addition to being of technical importance for the production of vanillin this discovery was a valuable contribution to our scientific knowledge of the structure of lignin and strengthened the early hypothesis of Klason (*29*) that lignin was essentially a condensation polymer of coniferyl and hydroxyconiferyl alcohols. The nitrobenzene-alkali process for producing vanillin from lignin is thus entirely analogous to the long-known commercial process for producing vanillin from the closely related isoeugenol.



Coniferyl Alcohol

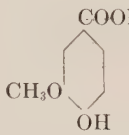


Hydroxyconiferyl Alcohol

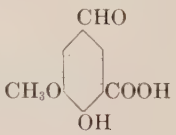


Isoeugenol

In addition to the high yields of vanillin, Freudenberg, Lautsch, and Engler reported the finding of small amounts of vanillic acid and of 5-carboxyvanillin in the alkaline nitrobenzene-lignin oxidation mixtures.



Vanillic Acid



5-Carboxyvanillin

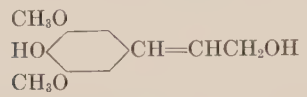
Hibbert and co-workers (*30*) extended the nitrobenzene process to hardwood lignin and Pearl and Lewis (*31*) studied the variables of the process at both atmospheric and superatmospheric pressures.

In a comprehensive study on the formation of vanillin from lignin materials, Freudenberg and Lautsch and their co-workers (*32*) found that, with finely dispersed oxygen and excess alkali in the presence of an oxygen carrier such as cobaltic hydroxide, sulphite waste liquor gave a maximum of 12% of vanillin on the lignin basis. These same authors treated isolated lignin with alkali and oxides of copper, silver, mercury, and lead, and found that the oxides of these metals did not increase the yields of vanillin obtainable from lignin by the use of alkali alone.

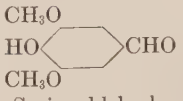
Breneck and Müller (*33*) reported increased yields of vanillin (about 8% on the lignin basis) on refluxing sulphite waste liquor with alkali in the presence of finely dispersed oxygen in the presence of various metallic oxides as catalysts. Freshly prepared cobaltic hydroxide was found to be the best catalyst for this purpose. Pearl (*34*) demonstrated that, in addition to nitrobenzene, another low potential oxidizing agent, freshly prepared cupric hydroxide, and alkali gave high yields of vanillin from sulphite waste liquor and other lignin materials. This observation was at variance with that of Lautsch and co-workers (*32*) noted above, although these investigators did not specify the type of cupric oxide they employed.

At this point, it should be mentioned that, whereas the lignin of coniferous woods is composed of only guaiacyl groups derived from coniferyl alcohol and the like, the lignin of deciduous woods contains, in addition to guaiacyl groups, syringyl groups derived from 5-methoxyconiferyl alcohol and related compounds. Therefore, when hardwood lignins are subjected to the above

described oxidation processes, syringaldehyde is formed in high yield together with the vanillin.

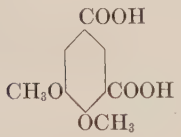


5-Methoxyconiferyl Alcohol

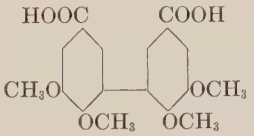


Syringaldehyde

Freudenberg and co-workers (*35*) heated sulphite waste liquor and lignosulphonic acid with caustic potash at 170°, methylated the alkaline solution with dimethyl sulphate, and then oxidized with potassium permanganate. These investigators reported yields up to 16% of veratric acid and up to 10% of isohemipinic acid. Similar experiments with isolated lignins yielded small amounts of dehydrodiveratric acid in addition to the veratric and isohemipinic acids, and experiments with beech lignin yielded trimethylgallic acid as the chief product of methylation and oxidation (*36*).

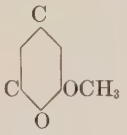


Isohemipinic Acid



Dehydroderivatric Acid

On the basis of these experiments and the isolation of 5-carboxyvanillin from the nitrobenzene oxidation of lignin, Freudenberg (*37*) has suggested that at least half of the basal units in spruce lignin are represented by the following structure.



Wacek and Kratzl and their co-workers have prepared numerous model phenylpropanesulphonic acids and have oxidized them with nitrobenzene and alkali under the conditions reported by Freudenberg, Lautsch, and Engler. On the basis of these experiments, they have evolved several generalizations concerning the structure of the side chains in the lignin molecule (*18*). The similarity of behavior with regard to vanillin yield between certain model substances and lignosulphonic acid under the same conditions was the criterion employed by these investigators.

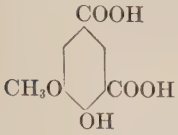
In a comprehensive program on the chemical utilization of sulphite waste liquor sponsored at The Institute of Paper Chemistry by the Sulphite Pulp Manufacturers' Research League the oxidation of sulphite waste liquor and lignosulphonate material with metallic oxides was investigated, even though a few years before (as noted earlier) Lautsch, Plankenhorn, and Klink (*32*) reported negative results in their attempt to increase the yield of vanillin by oxidizing lignin with alkali and the oxides of copper, silver, mercury, and lead. These authors extracted their vanillin from solutions buffered with bicarbonate and, therefore, lost any material which might be soluble in a bicarbonate solution.

Other work in our laboratory on the oxidation of vanillin to vanillic acid by means of silver oxide (*38*) and mercuric oxide (*39*) indicated that oxidation of lignin materials in the presence of metal oxides might yield vanillic acid instead of vanillin as the principal oxidation product. This was found to be the case when lignosulphonates were oxidized with alkali and either mercuric oxide or silver oxide. These investigations are reported in several patents and papers (*40*). Experiments with mercuric oxide and alkali, following the well-known work-up procedure of filtering, acidifying with sulphuric acid, and extracting with ether, confirmed the findings of Lautsch, Plankenhorn, and Klink (*32*) in that mercurated products were obtained. However, from these mercurated products, a new valuable slime control agent, 5-hydroxymercurivanillin, was obtained. It was found that preliminary acidification of the lignosulphonate-mercuric oxide reaction mixture with sulphur dioxide resulted in essentially complete decomposition of the mercurated products and made possible the further fractionation of the nonmercurated ether-soluble organic degradation products. These materials were separated into bisulphite-soluble, bicarbonate-soluble, alkali-soluble, and neutral fractions. The bisulphite-soluble fraction was essentially vanillin and acetovanillone, the bicarbonate-soluble fraction was chiefly vanillic acid, and the alkali-soluble fraction comprised in the main a mixture of vanillin, acetovanillone, and guaiacol. Other methoxyl-containing unidentified materials were also isolated. The yields of total ether solubles were approximately 60% of the lignin, and the yields of isolated vanillic acid were as high as 25% on the lignin basis. Although some vanillic acid is produced by alkaline nitrobenzene oxidation of lignin and lignosulphonates (*28, 31*), the mercuric oxide process was the first to yield vanillic acid in relatively large amounts. A new procedure for the isolation of vanillic acid from the bicarbonate-soluble fraction (based upon the solubility of vanillic acid in a neutral lead acetate solution) expedited the separation of this acid from the crude mixtures in very pure form.

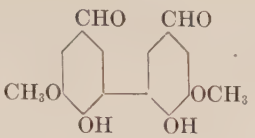
Similar oxidation of lignosulphonates in alkaline solution with silver oxide produced relatively high yields of vanillic acid with little or no vanillin. Overall yields of guaiacyl compounds were less than in the mercuric oxide oxidations. Further work on the silver oxide oxidation of lignosulphonate materials, especially fermented (*Torulopsis utilis*) sulphite waste liquors, indicated that 5-carboxyvanillic acid was obtained in relatively high yield, in addition to the vanillic acid (*41*).

The encouraging results obtained on the oxidation of lignosulphonate materials with mercuric oxide and with silver oxide prompted the reinvestigation of the oxidation of these materials with the more readily available cupric oxide under pressure. This process was found in the past to result in high yields of vanillin (by analysis) (*34*). Experiments on fermented sulphite waste liquor soon made it apparent that earlier yields of vanillin based upon precipitation with 2,4-dinitrophenylhydrazine were in error because this reagent was found to precipitate acetovanillone and other as yet unidentified guaiacyl compounds. Nevertheless, by changing reactant ratios, temperatures, and time of reaction, conditions were found for obtaining vanillin in isolated yields at least as good as the analyzed yields reported earlier. In addition to vanillin, the following guaiacyl derivatives were produced by the process in substantial amounts: guaiacol, acetovanillone, vanillic

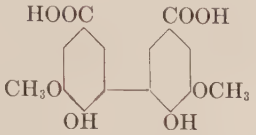
acid, 5-carboxyvanillin, 5-carboxyvanillic acid, dehydrodivanillin, and dehydrodivanillic acid (*42*).



5-Carboxyvanillic Acid

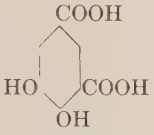


Dehydrodivanillin



Dehydrodivanillic Acid

These last three compounds have not been isolated heretofore from lignin. Although 5-carboxyvanillic acid has not been obtained as such from lignin oxidation mixtures, Freudenberg and co-workers' isolation of isohemipinic acid from their methylated mixtures indicated that either 5-carboxyvanillic acid or 5-carboxyprotocatechuic acid was present in their original reaction mixture.



5-Carboxyprotocatechuic Acid

Richtzenhain (*43*) obtained the methyl ester of 5-carboxyvanillic acid from a hydrochloric acid lignin-hydrogen peroxide oxidation mixture which had been methylated with diazomethane. Again, this experiment indicated the presence in a lignin oxidation mixture of either 5-carboxyvanillic acid or 5-carboxyprotocatechuic acid, but produced no evidence to indicate either specifically.

The same is true for dehydrodivanillic acid. Freudenberg and co-workers (*28, 35*) reported the isolation of dehydrodiveratric acid from methylated oxidation mixtures, but did not isolate the unmethylated guaiacyl derivative. Dehydrodivanillin has not been reported previously, even as its dimethyl ether.

The processes for the oxidation of lignin and lignosulphonates with alkali and mercuric oxide, silver oxide, and cupric oxide provide three new tools for the lignin research chemist. Continuation with these tools of the lignosulphonic acid model substance work so ably begun by Wacek and Kratzl and their co-workers with alkali alone and with alkali and nitrobenzene, and extension of this work to other lignin model substances should result in a much greater insight concerning the fundamental structure of lignin materials.

Thus it appears that we are on the threshold of a new era in lignin research—one in which oxidation will play a very important role. The situation today is certainly different from that extant just a few short years ago as represented in the following statement made by Max Phillips (*44*), one of our most eminent lignin chemists and one who has done outstanding pioneering work on the chemistry of the lignin complex—"Oxidation, one of the most important operations employed for the degradation of an organic substance, has not afforded results of particular importance insofar as throwing any light on the structure of lignin is concerned. When lignin is subjected to oxidation even under mild conditions, complete disruption of the molecule takes place and simple degradation products are obtained."

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Received March 15, 1950

Starch and Its Application in Machine Coatings

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The physical chemistry of starch in relation to its use as the adhesive in high density coatings is discussed. It is proposed that minimum starch sol and color viscosities and maximum adhesive strength result when the physical bonds holding starch molecules together are ruptured and when the dispersed molecules are reduced in size uniformly to a given minimum level. The mode of action of acid, enzyme, and oxidants in reducing the size of starch molecules is compared. Weakening of the physical bonds in the granule superstructure follows as a secondary effect in these reactions, particularly in hydrolysis, from a reduction of the size of the molecules in the granular network. The action of aluminum chloride hexahydrate on starch in the dry state is to weaken granular structure, depolymerize the starch molecules to the level suitable for adhesive applications, and alter the ratio of linear to branched polymer molecules in starch. Application of this reaction system has led to the production of starch adhesives of low viscosity and high adhesive strength suitable for use in high density coating colors. Combination of the aluminum chloride reaction and enzymic conversion is described for the production of high density coatings suitable for machine application.

STARCH is a well organized physical combination of two high polymeric materials called amylose and amylopectin which may be dispersed in hot water to give a paste or sol of relatively high viscosity. This viscosity of unmodified starch limits its usefulness in many sizing operations and is the result of two factors: first, the physical association between starch molecules, either the original association as it exists in the starch granule, which resists breakdown by water alone, or the reassociation of molecules that do dissolve when pastes are allowed to stand, and secondly, the viscosity which is due to the gigantic size of starch molecules when they dissolve.

The linear, or amylose, fraction of starch has the higher solution viscosity for a given molecular weight and shows a more pronounced tendency to reassociate. The molecules of the branched amylopectin fraction of starch on the other hand provide the structural framework of raw starch granules and are originally held together by strong physical forces. Once these physical bonds are disrupted, as by heating in water at high temperatures, the branched amylopectin molecules form more stable solutions. As compared to linear amylose molecules they then show less tendency to associate and to increase solution viscosity (*1*).

Accordingly, in many industrial applications for starch, such as in the machine coating of paper, the starch is treated to break down the molecules into smaller sizes and is then heated in water to break apart the physical forces holding the molecular fragments together. The reverse process may be used; in this case the starch is first heated in water and then chemically treated. The latter process comes into play when the paper converter uses an enzyme to modify starch in the preparation of a coating color. Breaking down the starch molecules to smaller size first, however, has the advantage that it becomes progressively easier, the more the starch is premodified, to rupture the physical associative bonds in granular starch by gelatinization. Indeed, even other ways of modifying starch besides hydrolytic breakdown, such as oxidation or dextrinization, increase the ease with which granular starch is dispersed on gelatinization. This is one of the principal disadvantages to the relatively simple expedient of enzyme converting native starch to prepare a coating adhesive since the physical, granular structure of the starch, which is chiefly responsible for the high viscosity of starch pastes, is not readily disintegrated by cooking until after the enzyme has cut the molecules into smaller sizes.

Before proceeding to a discussion and comparison of the several ways for modifying starch, which is the principal part of this paper, it may be well to consider more specifically the reasons for reducing native starch granules to the level where they are usable in machine coatings.

The majority of machine coating processes for applying clay colors to paper are designed to operate with high concentrations of clay, adjuncts, and adhesive in a water medium. There are, of course, several well recognized advantages (*2*) for using high concentration of solids: (a) higher machine speeds with the same amount of drying facilities, (b) more economical use of adhesive for a given strength, or pick, and (c) less masking of the gloss inherent in the clay. However, in order to attain the beneficial results of high solids processes, it is necessary that the starch should be modified in such a manner that it does not unduly increase the consistency of a 65 to 70% clay-water mass, which already is approaching the upper limits of permissible plasticity. The starch should be broken down so that it not only forms a very thin adhesive sol in limited amounts of water but also so that it disperses so intimately with the clay slip that only weakly associated aggregates of starch molecules and clay are present in the final color. This cannot be accomplished entirely by chemical breakdown and by ignoring physical association between starch molecules, since the adhesive strength or bonding power of starch is a function primarily of the size of starch molecules; if chemical scission is carried too far to compensate for poor dispersion, a weak coating is likely to result. Furthermore, the formation of an adhesive bond depends to some extent on freedom of movement of the starch molecules. To form a strong bond between a clay particle and pulp fiber, the adhesive should be able to flow around the surfaces of an enormous number of extremely small clay particles and to orient so as to form a continuous link to the surface of the pulp fiber. Obviously, starch gel

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particles are not as effective per unit weight as starch molecules above a certain minimum size.

Starch gel particles in coating colors contract excessively on drying and pits develop in the surface of the coated sheet. Gel particles of starch induce a *false* thixotropy in colors. Under the great shearing stresses exerted by roll applicators running at high speed, a reduction in body follows which is not quickly reversible, in contrast to true thixotropy which is reversible and which is a desirable characteristic for colors in the majority of machine coating processes.

From all of these considerations we may conclude that in reducing the viscosity of native starch to form a coating adhesive, disruption of the physical bonds which produce high viscosity is equally important, if not more so, than a properly controlled reduction in molecular size.

METHODS FOR MODIFYING STARCH

There are several ways available for breaking down starch into units of low viscosity.

Acid Hydrolysis

In this method the acid operates almost indiscriminately on all of the polymeric linkages in the starch molecules. The result is that instead of cutting up the high polymer molecules in starch into one range of sizes best suited for a particular operation, a great assortment of sizes results. Therefore, in acid hydrolysis, when an average molecular size is attained which gives the desired viscosity, some of the molecules are so small that they have little adhesive strength while some are so large that they still show exaggerated associative tendencies. In operating on starch granules at lower temperatures, the action of acid is even less uniform because of a physical barrier presented by the most highly organized sections, called crystallites.

Furthermore, dilute acid has very little effect in disrupting the physical bonds in the starch granule, and granular structure is weakened only by chemical scission of polymeric chains which tie together various crystallite regions.

Lastly, except under unusual conditions, acid does not change the structural pattern of starch molecules; both the linear and branched molecules become progressively smaller during acid hydrolysis.

Enzymic Hydrolysis

The chemical action of enzymes is similar to acid. The principal difference is that the enzyme does not act indiscriminately on the linkages of free molecules and, in the case of enzyme preparations now sold to paper coaters and for many other sizing applications, the enzyme cuts the starch molecules up into more uniform lengths; there is a minimum production of low polymeric sugar molecules except in the last stages of a hydrolysis. One disadvantage is that since the enzyme, itself, is a very large molecule compared to acids, and since it is so specific in action, it has considerable difficulty in aligning itself with and operating on starch molecules which are held or bound to other starch molecules by physical forces. Some heat treatment of the starch in water is required before the enzyme can function, and for perfectly uniform enzyme action, the starch should be thoroughly dispersed in water before the enzyme is added. Heretofore, it has not been practical to follow this promising road to perfection, particularly in formulating high density coatings, because of the large amounts of water and the very high temperatures required for dispersing starch. This subject will be discussed more fully in a following section.

Chemical Modification of Polymeric Units

In oxidation and some derivatization procedures, the glucose units of the starch molecule are reacted to form a more inherently soluble and more colloidally stable material. In oxidation, at least, the starch molecules may also be reduced in size by a degradative reaction. This method, in spite of its relatively high cost, has proved to be a very useful procedure for modifying starch to the level where it is applicable in clay coatings containing as high as about 50% solids. When one attempts to reduce the viscosity of starch by oxidation to the level where it is usable in colors containing 60 to 70% solids, the degradative reaction usually becomes so pronounced that the adhesive value falls below a desirable level.

Dextrinization

In the orthodox procedures for dextrinizing starch by heating in the dry state, the preliminary action is essentially hydrolytic, as pointed out by Brimhall (*3*). Indeed, a small amount of acid is usually mixed with the dry starch to act as a "catalyst" during the heat treatment. Simultaneously with the hydrolysis, however, and no doubt predominating in the last stages of dextrinization, a second reaction occurs in which the starch molecules, or fragments of starch molecules, are rejoined together. The noteworthy feature of this secondary reaction is that in the chemical rejoining process, branched and not linear molecules are reformed. As the starch is dextrinized under favorable conditions, the product shows a progressive reduction of linear molecules with less tendency to associate in solution and thereby increase paste viscosity. However, this modification does not necessarily involve a decrease in molecular weight.

APPLICATION OF DEXTRINIZATION PROCEDURES FOR CLAY COATING STARCHES

Considerable study has been made of the two major reactions involved in dextrinization, following the investigations of Brimhall. In early studies (*4*) an effort was made to control the hydrolytic reaction, since it was observed that the common dextrins were weak in adhesive value and showed abnormal associative tendencies in clay coatings, as will be shown additionally in a following table.

More recently attention has been directed to the study of dextrinization catalysts which would operate to reduce the viscosity of starch by disrupting the physical bonding in the starch granule, provide a regulated depolymerization of starch molecules and accelerate the formation of branched molecules from fragments of original starch molecules. It has been found (*5*) that aluminum chloride is a very suitable catalyst in the dry state for the production of coating starches. This reagent, even in amounts less than 0.1% (as hexahydrate based on starch) is a powerful depolymerization catalyst and weakens the physical bonds which hold the

starch molecules together in the granule far more effectively and under considerably less strenuous conditions than does acid. Its use as a condensation catalyst in organic reactions is well known and it has been found that it is a catalyst for condensation reactions such as the rejoining of starch molecule fragments to form branched structures.

Table I. Effect of Aluminum Chloride on Corn Starch

Heating time, min.	Product: Cold water soluble, %	Product: Paste viscosity by Stormer, sec. per 5 rev./20 g. wt.	Product: Linear polymer content, % by iodometric method
Starting, no heat	1.9	118.0	23.0
Heated to 105°, 0 min.	11.4	10.5	15.5
10	12.2	10.4	14.5
20	15.2	9.9	11.5
30	32.0	9.7	9.0
50	49.5	9.1	6.5

The action of aluminum chloride hexahydrate on starch in the dry state is illustrated in Table I. A starch slurry to which an amount of aluminum chloride hexahydrate was added sufficient to incorporate 0.1% by weight into the starch was filtered and dehydrated at low temperatures to about 6% moisture content. The reaction mixture was brought to a starch temperature of 105 to 110°C. and held for the periods of time shown in the table. The samples were cooled immediately and adjusted to pH 6 with ammonia gas.

While the cold water soluble content (indicative of granule rupture) progressed slowly at first and then accelerated, it will be observed that the viscosity decreased very rapidly at first and then leveled off. Inasmuch as viscosity did not continue to fall during the period of greatest disruption of the granule, it is apparent that the colloidal units—now mainly the molecules— were not progressively broken down to smaller and smaller fragments but that the scission became counterbalanced by a repolymerization reaction. That branched polymers were created from molecular fragments which arise in depolymerization is borne out by the change in composition of the starch by spectrophotometric analysis with iodine (*6*), which showed a progressive decrease in linear polymer content with time of heating.

The action of aluminum chloride cannot be accounted for by its acidity and its action is definitely more pronounced than that of other acidic salts at the same hydrogen ion concentration. Table II shows the

Table II. Depolymerization Effect of Acidic Salts at pH 3 on Corn Starch, Compared to HCl

Salt, or HCl	Cold water soluble, %	Paste viscosity By Stormer, sec. per 50 rev./500 g.	Solution viscosity in 2 N KOH at 25°C η_{sp}: 0.5% conc.
$AlCl_3.6H_2O$	10.4	2	0.09
$ZnCl_2$	0.7	22	...
$TiCl_4$	0.3	25	...
$Al_2(SO_4)_3.9H_2O$	0.9	202	...
HCl	0.3	200	1.30

comparative depolymerization effect of several salts on corn starch, when 0.1% was blended into the starch in a water slurry at pH 3.0 (the normal value in water for corn starch with this amount of aluminum chloride hexahydrate added), the starch mixtures carefully dehydrated and then heated to 105°C. in 15 minutes. The feeble effect of hydrochloric acid alone at pH 3.0 is given for comparison.

The paste viscosity of starch treated with aluminum chloride hexahydrate is difficult to compare on the Stormer viscometer using a 500-gram weight to actuate the spindle in a paste made by cooking 15 grams of the starch for 15 minutes in 280 ml. of water at 95°C.; the 2 second viscosity is substantially that of water under the same conditions. A better idea of magnitude is gained by comparing the specific solution viscosity (η_{sp}) of a 0.5% solution of the product in 2 *N* KOH at 25°C. The $AlCl_3$-treated starch had a value of 0.09 and the HCl-treated starch, 1.3.

Further difference between the mode of action of aluminum chloride and hydrochloric acid on starch may be seen from the characteristics of clay coatings at 45% solids content containing 20 parts of a commercial, acid dextrinized starch to 100 of clay compared to a similar coating color containing an equal ratio of an $AlCl_3$-treated product so modified as to give the same coating viscosity, as made.

Table III

Adhesive	Coating color viscosity by Brookfield, centipoises at 25°C. 1 hr.	24 hr.	48 hr.	Wax test on hand coated sheets
HCl-dextrin	9,200	19,600	24,800	3.5
$AlCl_3$-dextrin	10,000	9,600	10,000	5

The acid-made dextrin shows weak adhesive value and pronounced associative tendencies in the color as is shown by the large increase of viscosity with time whereas the $AlCl_3$-treated starch is satisfactory in both respects.

Table IV. Clay Coatings Containing 12:100 Parts of $AlCl_3$-Starch (All Dry Method) to HT Clay

Coating solids content, %	Viscosity MacMichael (7)[a]	Plasticity MacMichael (7)[a]	Dennison wax test
55	23	0	4
60	43	2.5	4

[a] Viscosity measured at 56 r.p.m., using No. 26 wire.

Pursuit of this study has led to the production of starch products modified by aluminum chloride with sufficiently low viscosity and rheological properties at a level which makes the starches eminently suited for use in clay coatings containing 60 to 65%, and higher, solids content and at the same time, they impart a satisfactory adhesive value to the coating. Mill operations extending over several years time have borne out the results of experimental studies.

Indeed, by a variation of the starch process in which the aluminum chloride is introduced into the starch in the dry state, dextrins of such low viscosity and plasticity have been developed that coating colors even in the range of 55 to 60% solids are sufficiently fluid to be applied in machine coating operations which involve either brush or air-knife applicators. Table IV shows the characteristics at 25°C. of coatings containing 12

parts of this type of dextrin to 100 of HT clay at solids content of 55 and 60%.

Recently, the aluminum chloride reaction has been extended to the pretreatment of starch intended for enzymic conversion. Enzymic hydrolysis of starch is now an established practice for preparing coating colors in the low density ranges and very satisfactory brush coatings have been prepared by this method. An obvious difficulty is encountered (*8, 9, 10, 11*) in the use of this method for the preparation of coatings in the solids concentration range of 60 to 70% for machine coating application; there is insufficient water in the formulation to provide for gelatinization and dispersion of the starch so that the enzyme may function properly. If one attempts to convert the starch by enzyme with the limited amount of water permissible without exceeding 30 to 40% water in the final color, plastic masses develop during preparation which are almost impossible to stir. If the starch is converted with clay, as suggested in one procedure, so as to make use of all of the allowable water for gelatinizing the starch, tremendous viscosities develop during the early stages of the heating period before the enzyme becomes sufficiently active and this severely taxes the facilities of equipment provided for the conversion. Local overheating due to inefficient agitation and the poor thermal conductivity of such plastic masses results usually in poor enzyme economy and weaker coatings than are possible for the amount of starch used. Nonuniform conversions are the direct result which lead to the secondary effects mentioned.

Acid may be used to premodify the starch in manufacture so as to reduce its hydration capacity during the early stages of the enzymic conversion, but in this case the obvious objections to acid hydrolysis and particularly to acid hydrolysis of starch in the granular state, are added to the enzymic conversion. Acid acts principally by hydrolysis of starch molecules, in a relatively nonuniform manner and is a very poor agent to promote a dissociation of the starch granule which is the principal cause of peak viscosities during the early stage of enzymic conversion.

On the other hand, aluminum chloride has a multiple effect on starch in the dry state and if starch is pretreated with this reagent in trace amounts, as in the drying of starch through continuous belt driers of the Proctor-Schwartz type, products result which are liquefied readily by enzymes when water ratios are used which are allowable for coating color formulations containing as high as 60 to 70% dry solids.

Two experiments follow which illustrate the use of these new modified starches in the production of high solids coatings by enzymic conversion.

Sixty-six pounds, dry basis, of corn starch treated with aluminum chloride hexahydrate was made into a slurry with 155 pounds of water. Calcium salts were added to give pH 6.8. One pound of "Vanzyme" was added and the mixture brought up to 76°C. in 30 minutes and then held at a temperature of 75 to 80°C. for 45 minutes. The conversion was completed by raising the temperature to 95°C. for 15 minutes. This mass was perfectly fluid at all stages even though the final adhesive was approximately 35% dry solids. Dudley viscosity of the adhesive was 60 seconds at 90°.

The adhesive was stirred into a clay slip consisting of 484 pounds (dry basis) HT clay, 1.5 pounds of tetrasodium pyrophosphate and 230 pounds of water. After high speed agitation for 30 minutes, the final color at 60% solids content had a Brookfield viscosity of 450 centipoises at 40°C. (60 r.p.m. using a No. 3 spindle).

In a second run, the starch was converted in the presence of the clay, using the following formulation (on dry solids basis):

66 lb.	$AlCl_3$-starch
484 lb.	Georgia Kaolin Co., No. 282 clay
1.5 lb.	Tetrasodium pyrophosphate
2 lb.	"Vanzyme"
6.2 lb.	Sodium silicate solution, as is, sp. gr. 1.39
370 lb.	total water.

This mixture at pH 7.2 was raised to 76 to 78°C. in about 15 minutes, with stirring, and held at this temperature range for 30 minutes, whereupon it was heated to 95°C. for 10 minutes. The final color at a dry solids content of 63% had a Brookfield viscosity of 1030 centipoises at 40°C. (60 r.p.m., No. 3 spindle).

During this conversion an ammeter in the line to the agitator gave a reading of 22 before the application of heat and showed a peak load of only 24 which occurred during the early stages of conversion.

Ordinary corn starch in a similar conversion stopped the agitator; even when water was added to reduce the solids content to 55%, the ammeter showed a peak load of 34.

The coating color made by enzyme conversion of the $AlCl_3$-treated starch was applied in machine coating, using roll transfer equipment located between stacks in the drying section of the paper machine. A paper stock consisting of 60% bleached groundwood and 40% sulphite pulp was used in two mill runs. In the first, 35-pound stock was coated with 7.5 pounds of coating color on each side of the sheet to increase the final paper weight to 50 pounds (25 × 38—500). The strength of this coating as measured by the Dennison wax test was 7. In the second mill run, a 60-pound stock was coated with 10 pounds of color on each side to produce an 80-pound coated sheet. The Dennison wax test was 5. Tests made on the color as applied showed 64.5% dry solids.

Colors containing as high as 67 to 68% solids content have been made and applied by similar methods.

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Received Nov. 29, 1949. Presented at the Annual Meeting of the Technical Association of the Pulp and Paper Industry, New York, N. Y., Feb. 20–23, 1950.

Contribution from the George M. Moffet Research Laboratories, Corn Products Refining Co. Argo, Ill.

Circulation Systems and Sulphite Pulping

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Results of a questionnaire sent to 105 sulphite pulp mills in the United States and Canada and answered by 82 mills show that a much larger percentage of production is made using circulation, both with and without external heaters. The percentage is higher for those mills which sell all or part of their pulp. Also, the percentage is higher for the mills producing the higher grades of pulp. A tabulation summarizing the results of the questionnaire is presented. A study is made between two bleached sulphite mills, comparing operation and results using circulation with direct and indirect cooking. The need for circulation in producing high-yield pulps is stressed. Several factors affect strainer design and location, as well as proper circulating pump operating characteristics.

CONSIDERING the title of this paper, it seems logical to study first what is being done throughout the industry at the present time. Therefore, this paper will be divided into four parts, as follows: (1) a survey of present cooking practice, (2) a comparison of digester cooking both with and without circulation and indirect heating, (3) some observations on the cooking of high-yield pulps, and (4) a consideration of design with respect to satisfactory operation.

In November, 1949, the author mailed a questionnaire to 105 sulphite pulp mills in the United States and Canada. This mailing list was taken from Lockwood's Directory and represents all sulphite pulp mills listed except those cooking in Mitscherlich digesters. Eighty-two answers to this questionnaire were returned, which is believed to be a remarkably high percentage of return; and the information from these answers is quite interesting.

TAPPI Special Report No. 368 was written in December, 1946, from information received from 46 sulphite mills. The report mentions that this return was from approximately 50% of those mills contacted by questionnaire. The answers were numbered from 1 to 46 and listed in the report, but no tabulations were made nor were any conclusions drawn from the answers. In the answers from the author's questionnaire, the mills remained anonymous; but the information was presented in such a way that it could be tabulated and definite conclusions drawn from a study of this tabulation. The specific questions asked covered the following:

A. Total daily production of pulp in air-dry tons.
B. Total daily production in air-dry tons segregated into newsprint, unbleached, bleached, and dissolving grades, and further segregated as to amounts of production sold on the market and converted in the manufacturers' own plants.
C. Number of sulphite digesters used and segregated as to those with no circulation, circulation only, circulation with indirect heaters, and circulation with Hydro-Heaters.
D. Is chip packing used? Is the cook fast or slow? Is a strong or weak acid used? Is a hot or cold acid system used?

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The answers from the 82 mills were taken and broken down into number of mills, number of digesters, tonnage produced, and percentage of tonnage of the total, each of these being classified as to type of pulp produced and whether sold or converted. Percentages of production were then calculated for the various grades being manufactured in digesters with no circulation, with circulation only, with circulation and indirect heating, and with circulation using Hydro-Heaters. Also, figures are shown in Table I giving total number of mills using chip packing, fast cooks, strong acid, and hot acid systems.

From the figures of the preceding tabulation, it is quite apparent that a much greater percentage of production is made using circulation of some type, either with or without heaters or Hydro-Heaters. It is also quite apparent that the percentage is greater for those mills selling all or part of their production. A very high percentage of all grades of pulp is produced using chip packing, a fast cooking cycle, strong acid, and a hot acid system. It is interesting to note that two thirds of the dissolving pulp production is made by circulation with indirect cooking, and one half to two thirds of these mills use chip packing, fast cooking, strong acid, and hot acid.

The replies received were broken down as to United States and Canadian mills. It was apparent from this study that production and cooking procedures were quite comparable in the two countries, so it appeared there would be no benefit from any attempt to embody this consideration in the final tabulation. For example, 62 questionnaires were sent to United States mills and 43 questionnaires to Canadian mills. Replies were received from 45 United States mills and 37 Canadian mills or, percentagewise, 72% from the United States and 86% from Canada, or an over-all return of 78% by number of mills. Of the replies, 58% of the number of digesters were in the United States and 42% in Canada. In terms of pulp production, 52% was United States and 48% Canadian. Of those mills selling all or part of their production, 23 were United States and 22 Canadian, and this production amounted to 4202 tons and 4057 tons, respectively. Of those mills converting their production, 22 were United States and 15 Canadian, or in terms of tonnage 2577 tons and 2195 tons, respectively.

The benefits of circulation only in a digester have been pretty thoroughly covered in previous papers, and it is probably a generally accepted fact among the industry that the addition of circulation will very definitely accomplish the following: (1) an improvement in pulp quality, (2) an increase in production, and (3) a savings in chemicals.

It is safe to assume that quality can be improved at least 5 to 10% or more with respect to burst, tear, and fold. Cooking times can be shortened, and higher yields obtained. In most cases, the percentage of

screenings can be materially decreased. Chemical savings depend somewhat on other existing equipment in the mill. More uniform bleachability can be obtained. With circulation it is easier to obtain a higher viscosity pulp and a pulp with a lower and more uniform copper number.

It is somewhat difficult to evaluate definitely the exact benefits which might be obtained by any particular mill by the addition of digester circulation. This is somewhat dependent upon the results and operations attained with the mill's existing equipment. Also, the maximum of all benefits cannot be obtained solely through the addition of digester circulation since a maximum improvement in one or two phases will limit the amount of improvement in other phases.

It is very difficult to obtain figures throughout the industry which evaluate the exact accomplishments of indirect cooking with respect to quality and production. It is a generally accepted fact that indirect cooking must be used with an acid recovery system if the liquor is to be concentrated. This is apparent because of the elimination of digester dilution which would throw an uneconomical load on an evaporator system. It is a fact that indirect cooking will maintain a stronger acid strength in the digester throughout the cook, because of the elimination of condensed steam. It follows from this that cooking can be speeded up or that other related benefits are realized. Another feature of indirect cooking is that the heater condensate can be returned to the boilers, with a resultant savings in boiler feedwater make-up if there is no danger from contamination by cooking acid because of leaks in the system.

The disadvantages of indirect cooking are the power requirements for circulation and the maintenance of the equipment. In pulp mills where a scaling condition exists within the tubular heater, the maintenance is quite high; but, if this scaling can be overcome through changes in operating procedure, the maintenance on a tubular heater should be negligible. Generally speaking, a properly designed circulating and indirect heating system (with respect to digester strainers, heater, and pump) should give very little trouble if operating procedures are adjusted to minimize any scaling tendencies. It has been found that using an acid with a low combined and proper filtration of the acid will be very beneficial with respect to scaling tendencies.

In an attempt to evaluate the accomplishments of indirect cooking, the author selected two pulp mills in the same locality using the same types of wood and producing the same grades of pulp. Several years ago, mill A installed circulation without heaters, and at about the same time mill B installed circulation with indirect heaters. Mill A experimented with one indirect heater and concluded that satisfactory results could be obtained without the use of this heater and that there was no appreciable savings of any kind to be made with the heater. However, a study of these experimental results definitely indicates extreme variation in the test data, and the author does not believe that sufficient tests were made to be definitely conclusive. Mill B installed heaters at the same time they installed circulation, so they have no experience on circulation only.

Both mills have excellent technical and research staffs and operate with excellent control. These mills have developed their techniques to suit the type of equipment they have and today are producing pulps which are just about equal in quality. The production rates of both mills are high, and their screenings are quite comparable. Again, this seems to emphasize the point that there are so many factors affecting the operation of a sulphite pulp mill that it is almost impossible to draw any definite mathematical evaluation. It is probably possible to pick two other pulp mills whose operating results would be widely divergent, as compared to the two mentioned above. The principal factors which affect this problem are: (1) acid plant facilities, (2) control of acid plant and cooking, (3) personnel, and (4) previous experience.

The fourth point above is a very important one, since there is a great reluctance on the part of management and operating personnel to try something new and something with which they themselves have not had personal experience. This reluctance probably rises from the belief that considerable time or production might be lost in adjusting their operating procedure to the new equipment. As shown in Table I, the great

Table I. Sulphite Pulp Cooking Survey

82 Mills of 105 Mills in U.S.A. and Canada (Excluding Mitscherlich Pulp)

	No. of mills	*No. of digesters*	*Total daily tonnage*	*Per cent daily tonnage*	*Per cent of tonnage*				*No. of mills*			
					No circulation, %	*Circulation only, %*	*Circulation and heaters, %*	*Circulation and Hydro-Heaters, %*	*Chip packing*	*Fast cook*	*Strong acid*	*Hot acid*
Class I—Mills *Selling* All or Part of Their Production												
Newsprint pulp	4	35	1,313	15.8	47.1	36.2	0	16.7	1	3	4	4
Unbleached pulp	16	60	2,214	26.8	27.0	43.6	7.4	22.0	12	15	14	14
Bleached pulp	19	99	3,224	39.1	18.2	22.1	54.1	5.6	13	17	18	15
Dissolving pulp	6	39	1,508	18.3	37.7	0	62.3	0	3	4	4	4
Subtotal	45	233	8,259	100.0	28.8	26.1	34.4	10.7	29	39	40	37
Class II—Mills *Converting* Their Production												
Newsprint	10	43	1,360	28.5	69.6	10.7	0	19.7	7	8	10	10
Unbleached pulp	7	46	1,120	23.5	46.8	12.5	15.3	25.4	4	3	5	6
Bleached pulp	20	81	2,292	48.0	34.5	21.2	30.9	13.4	12	14	16	13
Dissolving pulp	0	0	0	...	..	..	..	..	0	0	0	0
Subtotal	37	170	4,772	100.0	47.5	16.1	18.4	18.0	23	25	31	29
Total—Class I and Class II	82	403	13,031	100.0	35.5	22.5	28.6	13.4	52	64	71	66

majority of the pulp produced on this continent is cooked with circulation and frequent use of indirect heating is made, so there should be no particular problem involved in following these established procedures, provided that the equipment is well designed.

Hydro-Heaters, a comparatively new development in the industry, are a type of injector whereby steam is introduced into the acid circulating line of an external circulating system. It seems agreed that the use of a Hydro-Heater permits the use of automatic control instruments on a digester which control temperature and cooking cycle to a very fine degree. The circulating system is of extreme benefit to the cooking process, and it probably is somewhat doubtful if the extremely close control through the Hydro-Heater provides any additional benefit over a well-designed circulating system with suitable controls.

It is obvious that a Hydro-Heater would be uneconomical to use in a pulp mill considering the evaporation of their waste liquor, because of the dilution of the steam condensed within the digester. Also, there are some indications from an existing installation that the heating of acid in a circulating line by means of a Hydro-Heater increases scale formation in the circulating line with a resultant increase in the rate of corrosion which is quite serious from the standpoint of maintaining stainless steel circulating piping.

The cooking of high-yield pulps, particularly for newsprint production, has become prominent quite recently. The first consideration in connection with high-yield pulps is the use of chip packing as a means of increased production and resultant chemical savings. High-yield pulps are produced by one or a combination of the following: (1) lower cooking temperatures, (2) shorter cook, and (3) lower liquor ratio.

Some operators feel that the use of a lower cooking temperature is the best means of raising yield, as this provides better chip penetration.

It appears quite important in cooking a high-yield pulp that excellent circulation of the digester must be obtained. One West Coast mill cooks newsprint in noncirculated digesters and market pulp in circulated digesters. Experiments were run in the circulated digesters on high-yield pulps with very satisfactory results but, as soon as they attempted to reproduce these results in the noncirculated digesters they found their temperatures and qualities throughout the digester at wide variation; and it was their conclusion that circulation would have to be added in order to produce a news grade of suitable quality if the yield were going to be increased.

As previously mentioned, circulating system design is of extreme importance and, unless the equipment functions in a satisfactory manner, results will not be good.

Digester strainers, as a means of withdrawing liquor from the digester, are one of the most important considerations. Many of the early systems were designed to take the liquor out of the digester close to the top and return all circulated liquor to the bottom of the digester. This has the disadvantage of insufficient liquor above the strainers to maintain a positive high rate of flow, particularly toward the latter part of the cook and after the side relief has been taken off. Also, at times there is a tendency for burned chips in the top of the digester. Another school of thought believes in taking all of the liquor out of the bottom cone and returning it to the top of the digester. From the thermodynamic theories involved, this is good; but in practical operation several troubles are encountered. First of all, removal of the liquor from the bottom of the digester tends to pack the bottom cone and frequently causes difficulty in obtaining clean blows. Secondly, there are problems involved in the design of a strainer to go into the bottom cone, both from the structural and cost standpoints. Thirdly, there seems to be a much greater tendency for the strainers to plug at such an extremely low point in the digester.

Important points to consider in the design of digester strainers are as follows:

1. Sufficient strainer area to feed circulating pump after softening of the chips, particularly during the latter part of the cook.
2. Mechanical strength of the strainers to withstand the stresses set up by the movement of pulp or chips in the digester.
3. A design such that stresses are not imposed on the digester linings, with consequent trouble because of spalled brick.
4. Shape of the strainers to be such that it offers little resistance to the movement of chips or pulp and does not provide a ledge or obstruction within the digester which prevents the digester from blowing clean.
5. Strainers should be located at the proper elevation to accomplish the intended results.

In connection with point 5 above, it has been fairly well established that the strainer should not be located either close to the top of the digester or in the bottom cone, which leaves the question of optimum elevation in the straight section of the digester. If there is any possibility of using a low liquor ratio, this would tend to indicate that the strainers should be some place in the bottom half of the straight section. Various mills are experimenting at the present time in an effort to determine the exact point in the straight section of the digester that will give the best strainer results, and perhaps eventually this point will be determined. It has been definitely proved that the lowering of the strainers in the digester prolongs the length of time circulation can be maintained throughout the cooking cycle.

If the strainers are located at a low point in the digester, the problem arises as to how the liquor returned to the top of the digester should be introduced. Various types of spray rings and spray nozzles have been used, but there are apparently little data available as to the results accomplished by the different types. It is probably important to have some type of liquor distribution within the digester, if low liquor ratio or excessive chip packing is used. Ordinarily, this does not present a very serious problem; and in the normal type of cooking it seems sufficient to introduce the liquor at one or two points through the top dome without the necessity of using nozzles. In this case, with a normally high liquor level within the digester, the heat at the top of the digester will distribute itself and uniform results will be attained.

Circulating system pumps are a vital part of any installation, and it is well to consider proper design at this point. This is probably one of the most difficult pumping applications in the whole pulp mill and can be the most troublesome, if not properly designed and

maintained. Any type of digester strainer will impose some resistance in the flow to the pump suction, creating a difficult operating condition. Slow speeds and large impeller eye diameters are definitely advantageous because of this suction resistance and will tend to maintain circulation for a longer period of time throughout the cycle. The pump should have sufficient capacity to circulate the digester contents at least once every 12 to 15 minutes and, if used with an indirect heater, should have sufficient capacity to maintain a velocity within the heater of 12 feet per second in order to minimize scale formation. The design of the stuffing box is extremely important, as improper operation at this point can cause excessive maintenance or shut-down time. The trend is to use a water-cooled and lubricated stuffing box, and satifactory results can be obtained if the manufacturer's instructions are followed in connection with the high-pressure sealing water.

A comparatively recent development in pump design is the use of a double volute which gives complete radial balance to the pump rotating element. This feature should be quite an improvement since with a conventional type pump any unbalance present will affect proper operation of the stuffing box.

In conclusion, the survey indicated that the major portion of the sulphite pulp produced in the United States and Canada is produced using circulation of some type (either with or without indirect heaters or Hydro-Heaters), particularly in the manufacture of the higher grades of pulp. Correct design and proper maintenance of all parts of the circulation systems are of vital importance, as are operating techniques within the mill, in order to attain the desired results of improved pulp quality, increased production, and chemical savings.

Received Feb. 23, 1950. Presented at the Annual Meeting of the Technical Association of the Pulp and Paper Industry, New York, N. Y., Feb. 20–23, 1950.

The Author wishes to express his sincere appreciation to the pulp mill operators who so kindly filled out and returned the questionnaires sent to them.

Hydrapulper Processing of Straw

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A description is given of a mill system which utilizes the Hydrapulper for pulping straw. Data are given on several experimental cooks and paper machine trials.

For the past decade various experiments have been made using the Hydrapulper for wet chopping of straw, hot liquor impregnation, precooking, pulping of cooked straw, and, finally, the complete cooking of straw ready for refining. All these experiments indicated the possibilities of using this equipment in the processing of straw.

During the past year with the cooperation of the Dilts Machine Works Co. and the Northern Regional Research Laboratory a series of experiments were carried out at both Fulton, N. Y. and Peoria, Ill. by the Ball Brothers Co. which pointed to a promising method of processing straw for use in 9-point corrugating strawboard. These experiments were made with a 3-foot laboratory model Hydrapulper and other auxiliary equipment as previously reported by Aronovsky and Lathrop (*Tappi* 32, No. 4: 145–149 (April, 1949)).

Upon the optimistic reports of this work our company decided to develop this method on a commercial scale and consequently ordered an 11-foot Hydrapulper of special design for this purpose. Since its installation, a series of experimental runs have been made varying cooking time, charging methods, chemicals, and temperature. Then two runs were made on the paper machines cooking and processing 15 tons of pulp each time and converting it into salable board of quality equal to or better than board made by the conventional methods. This paper presents the results of these two trial runs.

DESCRIPTION OF MACHINE RUNS

A description of the equipment and processing used during these trial runs might be best illustrated first by a stock flow diagram, shown in Figure 1. The 11-foot HC Hydrapulper is fabricated of steel and equipped with a belt drive with a 125-hp. motor.

The processing was as follows: the Hydrapulper was first charged with hot cooking liquor made up in the liquor room and pumped over at as close to boiling

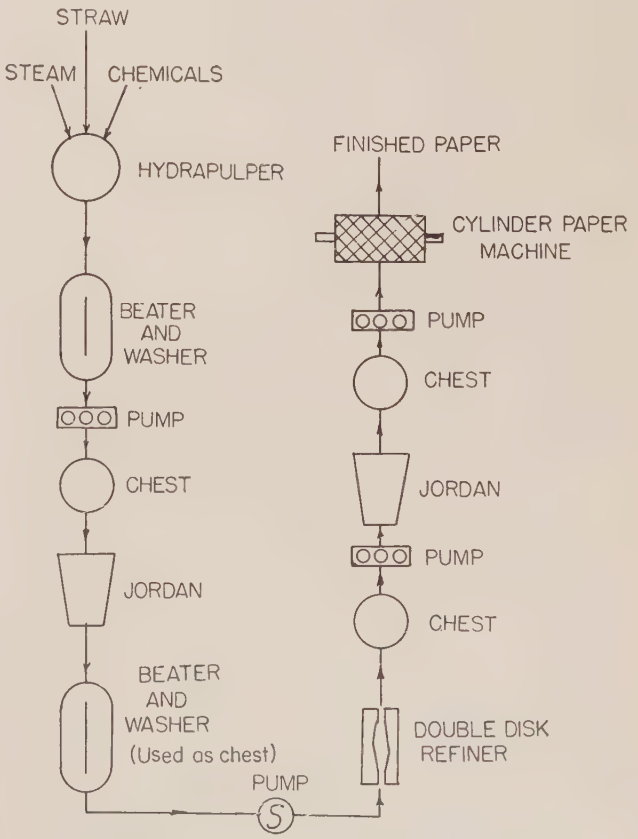

Fig. 1. Stock flow diagram—Hydrapulper cooking

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Table I. Hydrapulper vs. Digester Method Cooking Data[a]

Machine run no.	*Chemicals*	*Weight straw per cook, lb.*	*Cooking time, hr.*	*Temperature, °F.*	*Steam consumed, lb./ton AD straw*	*Water used, gal./ton*	*Consistency based on moisture-free straw, %*	*Yield average based on straw, %*	*Spent liquor, pH*
1	6% Lime, 4% soda ash	2,155	1	205	1350	2240	10	80[b]	10.3
2	5% caustic	2,400	1	205 (Atmospheric pressure)	1700	2000	12	81[b]	10.6
Digester cooked straw	Lime and soda ash or sodium sulphite and soda ash	10,000	6	270°F., 50 lb. pressure	2250	400	30	68 (Based on 1948 av.)	9.0

[a] Data based on 12% moisture in straw.
[b] Data based on 24-hr. runs.

point as possible. About 2400 pounds of straw, based on 12% air-dry moisture content, was added; the bale ties being broken, and the whole bales tossed in as rapidly as possible. Steam was introduced immediately to keep the temperature up to 210°F., and the rotor was started.

Cooking was continued for 1 hour at which time the pulp was dumped into an 1800-pound cast-iron tub beater equipped with conventional beating tackle and a drum washer, driven by a 75-hp. motor. Here a light brushing and washing was given the cooked straw for 1 hour, after which it was pumped to a storage chest.

From the storage chest through a regulator flow box the partially washed stock flowed through a jordan of special design driven by a 150-hp. motor. From the jordan the stock was pumped into a drainer conveyor equipped with showers for washing and then fed into a double disk Bauer refiner driven by two 150-hp. motors. The stock was refined at a 0.015-inch setting of the plates and dropped into a storage chest.

From this point the pulp was pumped into a regulating flow box where it was blended with a quantity of defibered waste paper, mainly corrugated scrap, and passed through two mammoth junior Noble and Wood jordans driven by 100-hp. motors. These jordans, equipped with conventional tackle, are set up in series and discharge into the machine chest.

Straw was cooked and processed over a 24-hour period with this equipment arrangement on Sunday, and run off on Monday morning over a 6-hour period on two strawboard machines, one a single cylinder, and the other a dual-cylinder machine. The stock was run at speeds of from 240 to 270 f.p.m.; it handled similarly to stock cooked in digestors and processed with beaters and jordans except that it dried a bit harder.

TECHNICAL DATA

Technical data covering two trial machine runs are shown in Tables I, II, and III.

In Table I, listing cooking data on both Hydrapulper and digester cooked straw it will be noted that there is a direct steam saving on hydrapulped straw of from 550 to 900 pounds of steam per ton of straw. The caustic cook shows a lesser consumption of steam, probably because of the heat of reaction in making up the chemical charge.

The yield figures show a remarkable saving of straw of from 12 to 13% and can be explained by reason of the shorter length of cook giving less time for the pentosans and lignin to dissolve and be washed away. The yield data on washed digester-cooked stock covered a 1-year operation in 1948, while the hydrapulped straw values covered only the 24-hour runs. The Hydrapulper yield was secured from a carefully calibrated beater.

The pH of the hydrapulped straw spent liquor was obviously higher because of shorter cooking time as compared to digester-cooked straw, and it is evident that in commercial operation of such a system, the spent liquor should be recovered.

In Table II, which lists refining data comparing the two systems, the freeness of the hydrapulped straw was considerably below that of the digester-cooked straw, which can possibly be explained by insufficient washing of the stock in the Hydrapulper system. This claim is substantiated in part by noting that the freeness of the hydrapulped straw was equal to that of the digester-cooked straw when both pulps were put not through the Bauer refiner, but through a finishing beater where adequate washing was given the stocks.

The freeness of the jordaned stock at the machine remained practically the same as the refined stock despite additional treatment at the jordan, probably because of blending with 30 to 40% waste paper.

In Table III, the finished paper made by both processes are compared using the usual standards and testing methods for 9-point corrugated paper. It will be noted that the stiffness of the sheet as measured by a standard

Table II. Refining Data—Hydrapulper vs. Digester Stock

Run No.	*Average breaker beater consistency, %*	*Average breaker beater freeness ml.*	*Bauer refiner*		*Machine jordan*		*Finishing beater*	
			Average consistency, %	*Average freeness, ml.*	*Average consistency, %*	*Average freeness, ml.*	*Average consistency, %*	*Average freeness, ml.*
1	4.7	320	2.3	360	2.5	340	2.3	350
2	5.52	300	2.7	350	2.7	375[a]	3.7	430
Digester stock	6.2	450	4.0	400	2.8	365[b]	3.0	350

[a] Contained 40% waste paper.
[b] Contained 30% waste paper.

Table III. Comparative Tests on Machine Made Paper-Hydrapulper vs. Digester-Cooked Straw

Machine run No.	Date	Furnish, %	Basis weight, lb./1000 sq. ft.	Caliper, 0.009 in.	Bursting strength, direct reading, p.s.i.	Tear direct reading MD, grams	Tear direct reading CD, grams	Riehle,[a] direct reading MD, lb.	Riehle,[a] direct reading CD, lb.	Stiffness lb. Riehle MD per lb./basis wt.
(1) 90-inch machine	10/24	Straw, 100	37	10.5	40	96	128	36	22	0.98
	10/24	Straw, 70; waste paper, 30	30	9.2	29	72	100	30	18	1.00
(1) 110-inch machine	10/24	Straw, 70; waste paper, 30	32.5	9.2	30	100	116	30	19.5	0.93
(2) 90-inch machine	10/31	Straw, 60; waste paper 40	34	100	35	120	136	35	23	1.03
	10/31	Straw, 50; waste paper, 50	32	9.5	38	112	120	36	22	1.12
	10/31	Straw, 25; waste paper, 75	32	9.5	48	128	144	32	22	1.00
(2) 110-inch machine	10/31	Straw, 75; waste paper, 25	34	9.5	38	112	140	35	22	1.03
					90-inch machine					
Normal operation digester cooking	10/25	Straw, 70; waste paper, 30	30.5	9.0	36.4	88	128	29.7	16	0.97
	10/26		30.8	9.3	35.0	100	132	32.0	18.7	1.04
	10/27		30.3	9.2	31.0	88	128	29.4	16.1	0.97

[a] Riehle test readings based on using 1/2- by 2-inch test strip.

Riehle tester is comparable in both processes, with the caustic hydrapulped straw having a decided edge. However, in all cases it was necessary to use a high percentage of waste paper with the hydrapulped straw to secure a freeness of stock which would give adequate formation and improve drying qualities at economical machine speeds.

The tear and burst tests were comparable in all cases with the caustic hydrapulped straw giving exceptionally high tear. The hydrapulped straw tended to bulk up a little more than that from the digester.

On the whole the hydrapulped straw ran very well, especially when sweetened with a large percentage of waste paper which, strangely, did not effect the stiffness of the sheet too adversely.

The pilot plant used in this trial run was not representative of what a hydrapulping system should be. Aside from adequately sized Hydrapulpers, preferably two in number, there should be ample storage facilities for the cooked stock followed by refining equipment using either disk refiners, conical refiners, or Hydrafibers, with perhaps a cycling system. This should be followed by adequate washing, jordaning, and screening of the pulp before running it on the machine. Supplementing the straw furnish a waste paper system should be set up so that a large proportion of this cheap type of furnish can be blended with the straw pulp.

SYSTEM ADVANTAGES

1. The Hydrapulper processing method has an important advantage over present methods in that it allows the quick charging of whole bales of straw by mechanical means without manual handling. The arduous task of stacking straw in the digester room, charging the digesters, and rodding and dumping them is eliminated. Handling of the cooked straw in the stock pits and breaker beaters can be eliminated. After hydrapulping straw, the pulp can be handled in slush form.

2. The many digesters with their troublesome drives, the beaters, presses, or rod mills can be eliminated by the use of this method with its fewer pieces of equipment of a type that can be maintained easily.

3. It is estimated that approximately 2 man hours per ton of paper can be eliminated in the average straw mill with this process which amounts to about $2.50 per ton paper.

4. It appears that 1000 pounds of steam per ton of straw might reasonably be saved and, transcribed into coal, might save $0.30 per ton paper.

5. An increased yield, conservatively estimated at 10%, will amount to a tremendous sum of money in the course of a year in the average straw mill. Figuring on an average delivered price of straw of $15 per ton of paper, one should save $1.00 per ton of paper from this source.

6. Another saving would be that of lower insurance charges in discontinuing the use of pressure equipment.

7. Possibly a saving in chemicals can also be brought about.

8. In regard to power it appears that possibly there will be a small increase in power with a Hydrapulper system. Most straw mills can operate with 20 hp. per ton per day for stock preparation up to the machine room. A power consumption of 22 or 23 hp. per ton per day appears likely for a hydrapulping system.

9. Hydrapulped straw should undoubtably be cleaner stock because of the washing action within the pulper and the likelihood of foreign materials of all sorts being thrown out at this point by centrifugal action.

10. The pulp can be blended with a large proportion of relatively cheap waste paper.

11. The safety hazards reduced by reason of eliminating the pressure operated digesters, and the drives, dump and drag conveyors, stock digging, presses, and belt-driven equipment would be of tremendous help in decreasing painful lost-time accidents, with the resulting medical expense, compensation time, and money loss to the employees.

12. From an operating standpoint there would also be an important advantage in hydrapulping by simplifying stock preparation and allowing it to become a streamlined continuous system with fewer pieces of equipment to maintain and watch. The stock as a result should run more uniformly and be more easily controlled as to quality, very important factors in today's market.

From the facts and data presented it would appear that the hydrapulping method can produce corrugating paper of equal or better quality than now produced, and can do this at an extremely large saving in labor, coal, straw, maintenance, and insurance, which would possibly total $5.00 per ton of paper.

Received Dec. 30, 1949. Presented at the meeting of the TAPPI Fibrous Agricultural Residues Committee, Terre Haute, Ind., Nov. 7-8, 1949.

Studies of Dielectric Properties of Chemical Pulps

III. Dielectric Properties of Cellulose

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A test capacitor embodying several desirable features has been designed and constructed for use with a Schering bridge. The loss angle and dielectric constant of native cellulose has been measured at frequencies from 500 to 4000 cycles per second at temperatures from 25 to 105°C., under conditions that assure no inaccuracy as a consequence of the presence of moisture. The observed behavior can be adequately explained if cellulose is regarded as a heterogeneous linear polymer with many polar groups. Similar measurements with regenerated celluloses showed significant increases in both loss angle and dielectric constant as compared with native cellulose. When these celluloses are subjected to moderate pressures, these values are reduced. A possible relationship between the observed dielectric constant and amorphous cellulose content (estimated by moisture regain) was found. However, the evidence is contradictory (a presumably amorphous cellophane was comparable with native cellulose), and no definite conclusions may yet be drawn.

PAPER HAS WIDE and varied uses as an insulator in the electrical industry, because of its low power factor, easily controlled dielectric constant, desirable physical properties, and its relative economy. Although much research has been carried out upon commercial papers, little attention has been focused upon an understanding of the dielectric properties of the constituents of these papers, and particularly cellulose. Such knowledge may lead to a better understanding of the dielectric behavior of electrical papers. Furthermore, dielectric properties are intimately related to physical structure, and might prove useful in elucidation of our knowledge of the physical chemistry of cellulose.

REVIEW OF PREVIOUS WORK

Delevanti and Hansen (*1*) have adequately reviewed the fundamental theories of dielectric behavior and the literature concerning electrical papers. Only investigations pertinent to this present work will be discussed here.

Stoops (*2*) measured the dielectric constant of cellulose in the form of cellophane over a wide range of frequencies and temperatures. He found the dielectric constant to be 7.6 at 1000 cycles at 25°C., which increased slightly at higher temperatures and lower frequencies. The power factor reached a minimum value of 1% at temperatures from 20 to 50°C., the temperature of the minimum decreasing at lower frequencies. Cellulose acetate had a lower dielectric constant and slightly lower power factor. Stoops attributed electrical loss to rotation of cellulose chains. His drying techniques are questionable in the light of more recent work.

Dielectric constant values for cellulose from 3.9 to 7.5 have been reported (*3*, *4*). The most reliable value is that of De Luca, Campbell, and Maass (*5*), who found a value of 6.1 at 25°C.

Delevanti and Hansen (*1*) found that the dielectric constant of kraft paper was related to density by the classical Clausius-Mosotti relation, where ϵ is dielectric constant and D is density.

$$(\epsilon - 1)/(\epsilon + 2) \propto D \qquad (1)$$

They found that loss factor and density bore a linear relationship. Endicott (*6*) derived several semiempirical relations that were adequate over moderate density ranges. Calculations showed that, over wide ranges, the relations failed.

The relation between moisture content and dielectric properties of cellulose-containing materials has been extensively investigated. The presence of moisture has been shown to cause increased conduction in cotton fibers (*7–9*). Argue and Maass (*10*) and Garton (*11*) both concluded that adsorbed water is increasingly tightly bound to cellulose as water is removed. Greenfield (*12*) showed that, although a small amount of water has little effect upon the dielectric constant, it contributes excessively to dielectric loss. He and Houtz and McLean (*13*) concluded that water adsorption follows Freundlich's adsorption isotherm. Others (*14*, *15*) have shown that the mechanism may be more complicated and that dryness is a relative term in the case of a complex polymerlike cellulose.

Cellulose exhibits an affinity for cations. The presence of these metallic contaminants has been shown to lower electrical resistance (*16*, *17*). Their deleterious effect is enhanced by the presence of moisture (*9*). Delevanti and Hansen (*1*) found that the presence of ash in kraft paper has little effect at low frequencies. Vogel (*18*) attributed increased loss of electrical papers at higher temperatures to the presence of electrolytes.

It is evident that the effect of moisture and ash must be eliminated in order to accurately measure the dielectric properties of cellulose.

EXPERIMENTAL PROCEDURES

Electrical Testing Equipment

A conjugate Schering bridge designed according to A.S.T.M. (*19*) and a transitron type oscillator were used for most of the electrical measurements. This equipment was built by Delevanti and Hansen (*1*) and is described by them.

The new test capacitor system is illustrated in Fig. 1. It consists of a pair of electrodes of suitable size mounted so that considerable pressure can be exerted upon the test specimen while electrical measurements are being made. The thickness gage is capable of the measurement of the electrode separation with an accur-

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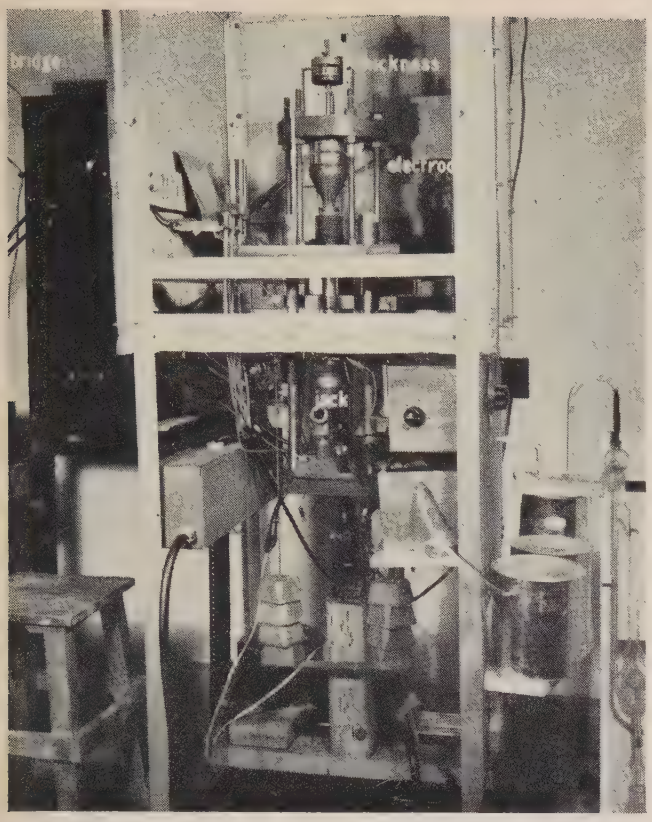

Fig. 1. Test capacitor system

acy of 0.0004 inch. A bell jar (not shown) encloses the electrode system and rests on the base plate. The system may be evacuated to a pressure of 0.1 mu. The apparatus is enclosed in a mounted shielded insulated box whose temperature can be controlled within 1 °C. from 25 to 105 °C.

A schematic diagram of the electrode system is shown in Fig. 2. The upper electrode and insulator are cemented to the upper plate. The lower electrode mount rides on a ball bearing on the upper shaft, whose movement, in turn, is controlled by a jack, mounted at the point indicated in the drawing. The upper electrode is therefore fixed in position, whereas the lower electrode may be raised or lowered. The sylphon bellows permits this motion and, at the same time, preserves the vacuum. The base plate contains the electrical leads and connections to the vacuum system and McLeod gage. With this apparatus, pressures up to 1000 p.s.i. can be intermittently exerted upon the test specimen.

The electrode separation gage is a capacitor whose separation is directly related to the separation of the main electrodes as shown in Fig. 3. The upper electrodes of both the gage and test capacitor are stationary. The spacing of the test capacitor is determined by the position of the lower electrode. The lower electrode of the auxiliary capacitor is flexibly mounted with regard to vertical movement only and its position is determined by the main lower electrode, since the glass rod that acts as the support of the lower electrode of the gage extends through the center of the main upper electrode and rests upon the lower main electrode through a hole cut in the test specimen.

The capacitance of the gage capacitor is measured with a capacitance bridge. Standard shims of known thickness were placed between the electrodes and the bridge balanced at a series of electrode pressures and temperatures. Suitable calibration charts prepared from these data were used to obtain electrode separations.

Method of Making Electrical Measurements

Several sheets of a particular cellulose were carefully selected for smoothness, good formation, and freedom from dirt specks. The specimens were inserted in place, and the apparatus assembled and heated to 105 °C. After equilibrium (15 hours), the specimens were placed under 940 p.s.i. by the jack. The temperature and the vacuum were noted and the auxiliary bridge was balanced. The Schering bridge was balanced at 500, 1000, 2000, and 4000 cycles per second. The lower electrode was lowered, and the temperature allowed to drop to the next desired value, equilibrium established, and the procedure repeated. Measurements were made at approximately 105, 75, 50, and 25 °C. The temperature was then raised and measurements made at these temperatures in a similar stepwise fashion. At the conclusion of the run, the vacuum was broken and the specimen was removed. The area of the specimen between the electrodes was carefully cut out, the area measured, and dried to constant weight at 105 °C. The density was calculated as the mean mass per unit volume between the electrodes. Dielectric constant and loss angle were calculated using the approximation formulas given by A.S.T.M. (*19*). The dielectric

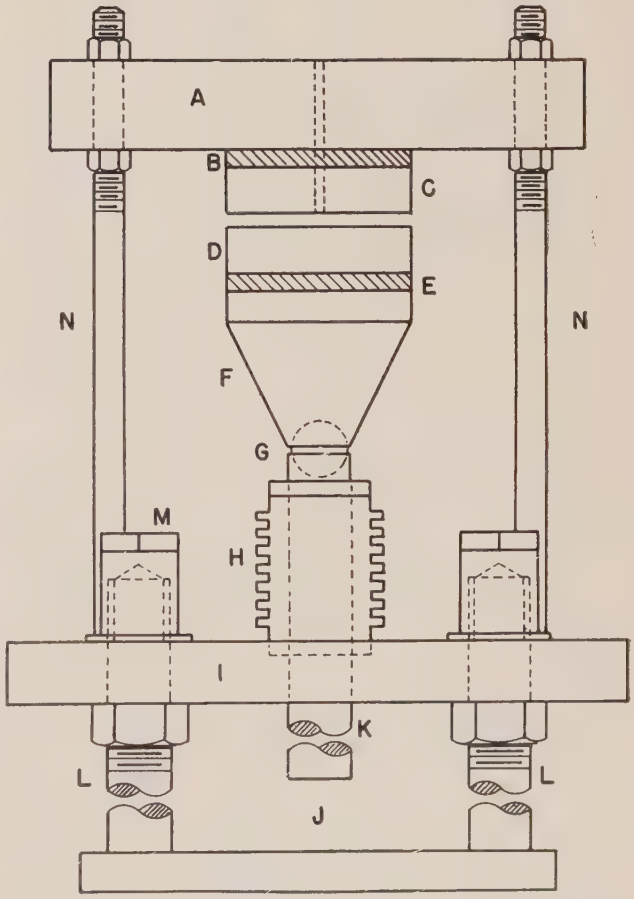

Fig. 2. Schematic diagram of electrode mounting system

A, Upper plate; B, upper main electrode insulator; C, upper main electrode; D, lower main electrode; E, lower main electrode insulator; F, lower main electrode mount; G, ball bearing; H, sylphon bellows; I, base plate; J, hydraulic jack (not shown); K, main shaft; L, jack frame; M, cap nuts; and N, connecting shafts (only 2 shown).

constant was calculated to standard density (0.8 gram per cubic centimeter) by means of the Clausius-Mosotti relation. Loss angle was calculated to standard density by the method described by Delevanti and Hansen (*1*), assuming that loss factor and density bear a linear relationship. Dielectric constant and loss angle at standard density are designated $\epsilon_{0.8}$ and $\epsilon'_{0.8}$, respectively. At these low values, the loss angle and power factor are very nearly equal.

Sources of Error in the Measurements

The Schering bridge is inherently accurate, and the frequency of the transitron oscillator was stable and accurately known. Use of the approximation formulas was shown to introduce no appreciable error. The lead loss is small and was neglected. The new electrode system eliminates error due to spacing between the specimen and the electrodes. This was confirmed by measuring the loss angle of a specimen at a series of electrode pressures. At pressures of 800 p.s.i. or higher, observed values (corrected to standard density) became constant, indicating that spacing had been effectively eliminated. All measurements were made at a pressure of 940 p.s.i. upon the specimen. The

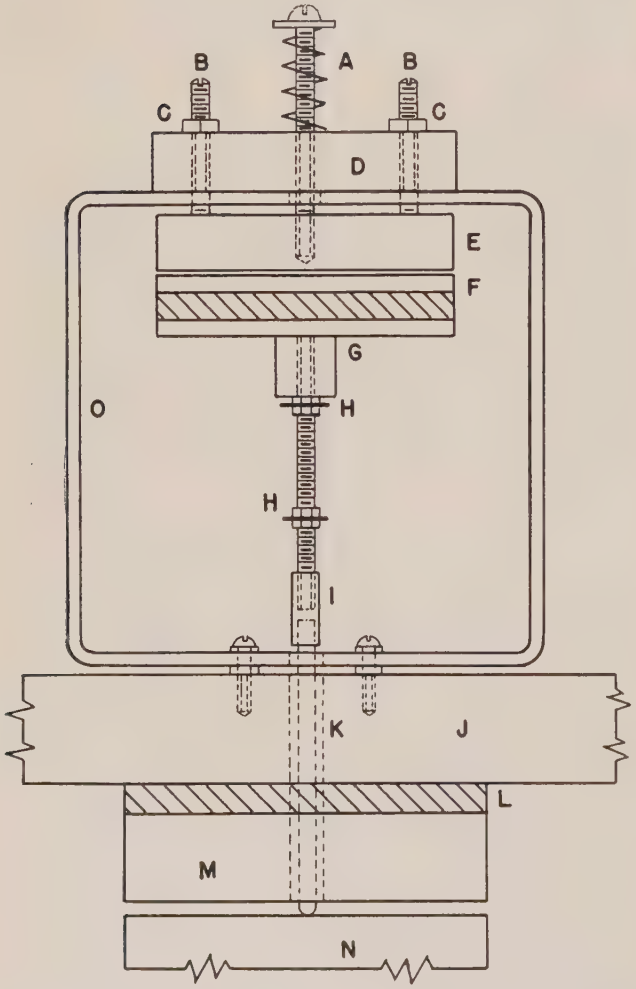

Fig. 3. Schematic diagram of electrode separation gage

A, Spring; B, set screws (only 2 shown); C, lock nuts; D, brass disk; E, upper electrode; F, lower electrode; G, lower electrode support; H, flexible support for lower electrode; I, glass rod holder; J, upper plate; K, glass rod; L, main upper electrode insulator; M, main upper electrode; N, main lower electrode; and O, support frame for gage.

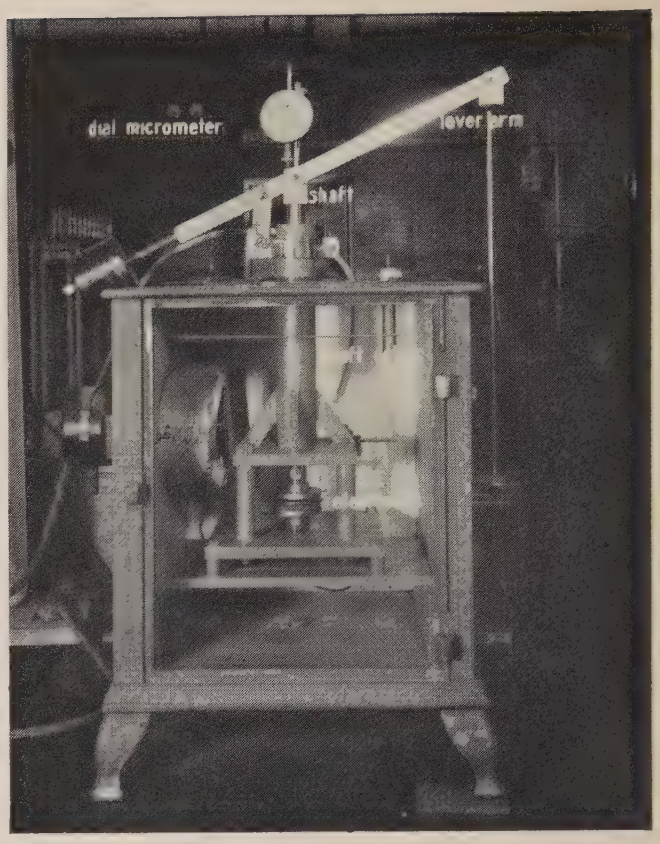

Fig. 4. Auxiliary dielectric constant apparatus

measurement of the dielectric constant of several specimens of native cellulose at different densities showed that the Clausius-Mosotti relation was applicable. Similar measurements of loss factor showed a slight deviation from linearity with density. The differences, however, were small and no appreciable error was introduced in the results by the assumption of linearity.

Equilibrium studies showed that 12 hours were sufficient for equilibrium loss angle measurements. The presence of moisture had no significant effect upon the results when the first stage of drying was at 105°C. This was shown in two ways. First, no hysteresis effect was observed in loss angle measurements, although it is known that, even at low gas pressures, hysteresis in moisture sorption does take place (*13*). Second, several tests were run at gas pressures up to 200 mu, rather than at 0.1 mu. No differences were noted in the loss angles at either pressure, except perhaps at 25°C., where the observed differences were within the experimental error. The dielectric constant was unaffected by the small changes in moisture content.

An estimation of the sources of error in the determination of dielectric constant indicated that the maximum error of a single measurement should be about 10%. Statistical analysis of some of the observed data in the case of native cellulose showed a standard deviation (for individual data) of less than 5%, in good agreement with the estimation. Similarly, the maximum error of a single loss angle measurement should be of the order of 10%. Standard deviations of the data varied from 4 to 6%.

The results show that both loss angle and dielectric constant determinations may be considered sufficiently accurate and precise for the purposes of this investigation.

Auxiliary Dielectric Constant Apparatus

As this investigation proceeded, the need for an auxiliary apparatus for the purpose of making independent and rapid dielectric constant determinations became apparent. A plastometer was modified for our purposes. A photograph of the completed apparatus is shown in Fig. 4. The upper electrode shaft is permitted vertical movement only by the shaft collar. The shaft is actuated by the lever arm. The lower electrode is stationary, and the electrode spacing is determined by the position of the upper electrode shaft. The foot piece of a dial micrometer rides upon the upper end of the shaft. The electrode separation is determined from the difference in the micrometer readings at zero and at the separation existing with a specimen in place. A moderate pressure can be exerted upon the specimens by loading the lever arm. The system is mounted in a laboratory oven equipped with a thermoregulator and a blower for the circulation of air. The capacitance is measured with a capacitance bridge connected to the electrodes through a rigid system of wires (to insure stable lead capacitance).

Desiccated air was bled into the oven to insure that all air flow was outward and that the specimens were conditioned in a dry atmosphere. [Previous investigations (*10, 12*) and preliminary experiments established that an extreme state of desiccation is not necessary for accurate determination of dielectric constant.]

Specimens were placed in the apparatus and conditioned at 65 to 70°C. until equilibrium was established. The door was opened, the specimen placed between the electrodes, the door closed, the bridge balanced, and the micrometer reading noted. The specimen was removed and the zero separation of the electrodes noted. Tests showed that this procedure did not produce error in the determination by permitting the specimen to adsorb significant amounts of moisture during the manipulation. The density was determined and the results were calculated to standard density in the manner previously described.

This equipment is probably not as accurate as the main apparatus. However, no significant differences could be noted between the results obtained in the two apparatuses for native cellulose.

DIELECTRIC PROPERTIES OF NATIVE CELLULOSE

Three native celluloses were tested. The first was a purified Hercules cotton linters (cellulose A), the second Whatman No. 50 quantitative filter paper (cellulose D), and the third bleached ramie fiber (cellulose K). Celluloses A and K were beaten in laboratory beaters, screened, washed, and extracted with dilute acid as described by Delevanti and Hansen (*1*). Sheets were prepared by a method similar to the one described by them. Several experiments were carried out in the case of celluloses A and D. One short experiment was carried out with cellulose K. No significant differences existed between these native celluloses although cellulose K appeared to have a slightly lower loss angle at the lower temperatures. These results are not surprising, since each is pure cellulose, chemically speaking, as Table I shows. Only one difference is apparent in the analytical data; the ash contents vary from 0.006 to 0.15%. However, such differences have no significant effect upon loss angle under conditions of desiccation employed in the present work.

Table I. Physical and Chemical Properties of Celluloses Tested

Cellulose	Description	Degree of polymerization	Carboxyl milliequiv./100 g.	Copper No.	H_2O regain at 54% R. H.[a]	Ash, %
A	Cotton linters	1450	Neg.	...	6.1	0.07
D	Filter paper	930	Neg.	...	6.15	0.006
E	Regenerated	..	..	...	10.7	0.1
F	Regenerated	..	0.2	...	10.9	0.21
G	High carbonyl	360	1.6	4.5	6.05	0.12
H	High carboxyl	240	6.3	0.5	6.3	0.1
J	Regenerated	505	Neg.	...	11.65	0.13
K	Ramie	1055	..	...	6.2	0.15
L	Cellophane	..	..	...	11.6	...

[a] Regain at 54% R. H. after 24 hours preconditioning at 25% R. H.

Table II. Dielectric Constant of Native Cellulose at Several Temperatures

Temp., °C.	$\epsilon_{0.8}$
25	2.42
50	2.36
75	2.41
100	2.50

The mean loss angle curves at standard density are presented as a function of temperature in Fig. 5. The dielectric constant values at 1000 cycles are given in Table II. No significant differences were noted at other frequencies. Using the Clausius-Mosotti relation, a value of 6.0 is found for the dielectric constant of solid native cellulose at 25°C. in good agreement with the value of 6.1 reported by De Luca, Campbell, and Maass (*5*). The data show that the dielectric constant goes through a very slight minimum and then increases with increasing temperature. Other investigators have noted the rise in dielectric constant with increasing temperature, but the presence of a minimum has not been reported. After thorough consideration it is concluded that the dielectric constant of native cellulose shows a slight rise at higher temperatures, and that it is probable that it goes through a minimum in this temperature and frequency range.

Cellulose is a linear polymer with many polar groups. In general such polymers show increased dielectric constant and loss angle with increased temperature and decreased frequency (*20, 21*). Cellulose is also a heterogeneous material and interfacial polarization may occur. This type of polarization decreases with increasing temperature and increasing frequency, because of the relatively large masses of the particles involved (*22*).

If this concept of cellulose is correct, then the ob-

Table III. Increases in Loss Angle of Native Cellulose As a Result of Degradation

Cycles / Temp., °C.	$\Delta\epsilon'_{0.8} \times 10^3$, radians 25	50	75	90
Carboxyl Groups[a]				
500	0.45	0.30	0.80	1.60
1000	0.35	0.35	0.55	1.25
2000	0.30	0.35	0.65	0.85
4000	0.15	0.20	0.35	0.80
Carbonyl Groups[b]				
500	0.05	0.10	0.30	0.25
1000	0.05	0.10	0.10	0.20
2000	0.05	0.15	0.15	0.20
4000	0.05	0.05	0.05	0.15

[a] 1 carboxyl group per 100 anhydroglucose units.
[b] 1 carbonyl group per 10 anhydroglucose units.

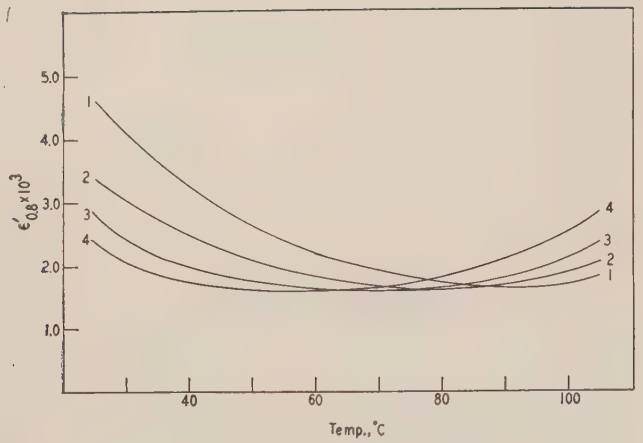

Fig. 5. Loss angle of native cellulose at several frequencies

Curve 1, 4000 cycles; Curve 2, 2000 cycles; Curve 3, 1000 cycles; and Curve 4, 500 cycles.

served loss angle-temperature relationship may be explained. If interfacial polarizations occur, the initial decrease may be the result of decreased loss as such polarizations decrease as a result of increased thermal agitation. However, the possibility of a low temperature region of anomalous dispersion cannot be ruled out. At higher temperatures, the loss attributable to polar groups increases, and a minimum is observed. This latter loss decreases with increasing frequency and, as a consequence, the minimum is shifted toward a higher temperature at higher frequencies.

The observed dielectric properties of cellulose are satisfactorily explained if cellulose is regarded as a heterogeneous linear polymer with many polar groups.

The dielectric behavior of native cellulose has been shown to be related to its polar character. In addition to the hydroxyl groups, carboxyl and carbonyl groups are found in cellulose. Their contribution to dielectric loss was ascertained by measurements carried out upon several oxycelluloses prepared from cotton linters according to the method of Birtwell, Clibbens, and Ridge (*23*). They were acid extracted, washed, and made into sheets in the same manner as the native celluloses. Analytical data indicating the content of carboxyl and carbonyl groups in celluloses G and H are presented in Table I. The copper number was used as a measure of carboxyl groups. Two experiments were carried out on each cellulose. In both cases higher loss angle values, as compared with native cellulose, were observed, particularly at higher temperatures.

The relative contribution of each group to the dielectric loss was estimated in the following manner. The increase observed in the case of cellulose H was assumed to be entirely due to the carboxyl groups present since the cellulose has a low copper number. The net increase at each frequency, as compared with native cellulose, was determined graphically, and is presented in Table III, together with similar data from cellulose G, which have been corrected for carboxyl content, using the results obtained with cellulose H.

The contribution of carbonyl groups to dielectric loss is negligible, except possibly at higher temperatures. Since this oxycellulose has a very high copper number, it may be concluded that carbonyl groups are not a source of appreciable dielectric loss in cellulose.

The contribution of carboxyl groups to dielectric loss is extremely high at higher temperatures, increasing with decreasing frequency. Since analysis shows only one carboxyl group for each 100 anhydroglucose units, the effect is considerable. It is possible that cellulose contains carboxyl groups not revealed by present analytical methods. However, the possibility that such groups are responsible for the observed rise in the case of native cellulose must be discarded, since the magnitude of the effect is not so large that one or two carboxyl groups per 1000 anhydroglucose units could be the cause.

No significant changes in dielectric constant as compared with native cellulose were noted. This is not unexpected, since the differences, as compared with native cellulose, although drastic chemically speaking, have affected physical structure only slightly.

Several interesting deductions may be made from these observations in conjunction with other data. Delevanti and Hansen (*1*) have reported loss angle values at standard densities at 1000 cycles for kraft pulps of 2.1 to 2.4 $\times$ 10^{-3} radians at 80°C. Native cellulose under the same conditions has a loss angle of 1.7 $\times$ 10^{-3} radians. If it is assumed that the pulp is 80% cellulose and that its contribution to dielectric loss is proportional to its weight fraction, the contribution of the remaining components is found to be more than one third of the observed loss, even in the case of the best kraft pulp. Delevanti and Hansen (*1*) found that the loss angle of a bleached kraft pulp was only slightly lower than that of an unbleached kraft. The source of excessive loss is evidently in the noncellulosic constituents of the pulp with both lignin and hemicelluloses contributing to the dielectric loss. The behavior of the latter can be explained readily, since it is generally accepted that most of the carboxyl groups present in pulps are found in the hemicellulose fraction. Delevanti and Hansen have shown that lignin contributes excessively to dielectric loss.

These views are substantiated by the work of Miller and Hopkins (*24*). They found that the removal of lignin and associated materials from kraft electrical paper reduced the power factor. Alkaline extraction of the delignified residue with the removal of 4% of the hemicelluloses (based upon original paper) caused considerable reduction in the power factor. A limited extraction of this type would remove the carboxylic fraction of the hemicelluloses and, as the results of this investigation show, reduce the dielectric loss. Further extraction caused large increases in power factor. Such

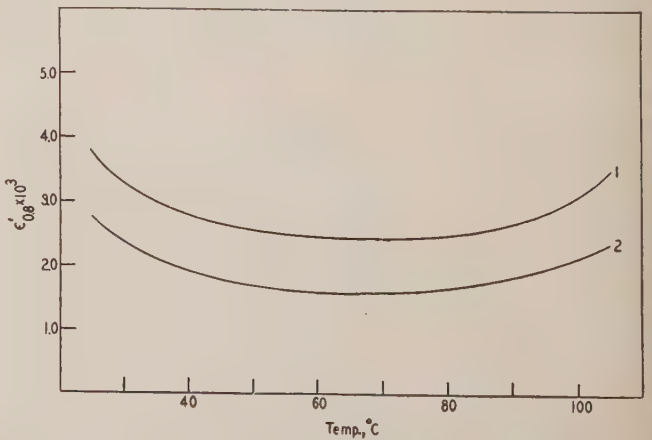

Fig. 6. Loss angle of regenerated cellulose at 1000 cycles

Curve 1, cellulose J and Curve 2, native cellulose.

extended treatment would not leave a pure native cellulose residue but rather might introduce considerable degradation which would account for the increase. Unfortunately, no analytical data of the residues were given.

It is believed that the following statement can be made. Improvements in the dielectric characteristics of present-day electrical papers are to be looked for in the elimination of those fractions of the noncellulosic constituents which contribute excessively to dielectric loss and, particularly, in the elimination of carboxyl groups.

DIELECTRIC PROPERTIES OF REGENERATED CELLULOSE

The previous section of this paper has been concerned with native celluloses which possess the normal crystal lattice (cellulose I) and are largely crystalline. Regenerated celluloses differ in two respects. The cellulose exists in a different crystal lattice and is largely amorphous as a consequence of the regeneration, according to Hermans (*25*). Most regenerated celluloses exist in the hydrate cellulose lattice (cellulose II). The terms crystalline and amorphous are used in the qualitative sense of indicating regular ordered arrangement and disordered random arrangement of cellulose chains, respectively.

Changes in the dielectric properties in comparison with native cellulose are possible as a consequence of these differences. In particular, if the amorphous content were related to the dielectric behavior, a valuable analytical tool might be developed.

Celluloses E, F, and J were prepared by regeneration from viscose according to the method of Jayme and Wellm (*26*). The viscose was precipitated into a turbulent regenerated bath and the cellulose obtained in a fibrous form. It was acid extracted, purified in the same manner as native cellulose, and stored in water. The moisture regain of these celluloses was almost twice that of native cellulose. Hermans has reported that amorphous cellulose has a much higher moisture regain than crystalline cellulose and, on the basis of his results, these celluloses must be considered amorphous. All exhibited plastic flow at low pressures, a property of amorphous materials.

The shrinkage of sheets prepared from these fibers was so great they invariably split upon drying. Splitting was avoided by slowly drying between stacks of blotters, but the sheets were somewhat wrinkled and, with few exceptions, were unsatisfactory for testing. Smooth soft sheets were prepared by drying these celluloses by solvent replacement, using methyl alcohol, ethyl ether, and cyclohexane in that order.

Two experiments were made with sheets of cellulose J prepared in this manner. The calculated loss angle values at 1000 cycles at standard density are presented as a function of temperature in Fig. 6. A similar curve for native cellulose is included for purposes of comparison. The dielectric constants at various temperatures, calculated to standard density at 1000 cycles, are presented in Table IV, together with similar data for native cellulose.

Similar results were found at all frequencies tested. Both loss angle and dielectric constant values are substantially higher than comparative values for native cellulose at all frequencies. Before the cause and significance of these results is discussed, it is necessary to be assured that these differences are characteristic of the celluloses.

Table IV. Dielectric Constant of Regenerated Cellulose at 1000 Cycles

Temp., °C.	*Cellulose J* $\epsilon_{0.8}$	*Native cellulose* $\epsilon_{0.8}$
25	3.5	2.42
50	3.6	2.36
75	3.8	2.41
100	3.9	2.50

The solvent treatment had no effect upon the results. Methoxyl analysis revealed only a trace of methyl alcohol. Ether is not retained by cellulose (*27*). No cyclohexane was retained by the regenerated cellulose, although native cellulose after similar treatment retained 2 to 5% [based upon gain in weight method after Staudinger and Dohle (*28*)]. Tests upon a specimen of native cellulose dried by solvent replacement showed no differences as compared with air-dried native cellulose.

The auxiliary dielectric constant apparatus was utilized to make a series of dielectric constant determinations upon celluloses E and J, which had been dried in several ways. The condensed results are presented in Table V. In all cases a definite increase in dielectric constant is found. The regenerated cellulose specimens are of substantially lower density than the native celluloses. The results are calculated to standard density by means of the Clausius-Mosotti relation. If this is not applicable to regenerated cellulose, the apparent increase could be a result of the calculation. In Table V the dielectric constant of native cellulose has been calculated to the apparent density of each regenerated cellulose sample and comparisons made. Significant differences still exist. Therefore, the observed increases are not caused by an error in calculation.

The regenerated celluloses exist in the cellulose hydrate lattice (cellulose II). It is conceivable that the observed effects are a consequence of this change. A specimen of cellulose J was heated in glycerin at 240°C. for 40 minutes [according to Kubo (*29*) this largely shifts the lattice to cellulose I, although Hermans states the shift is to cellulose IV]. No significant change was observed in the dielectric constant, although the moisture regain dropped from 11.6 to 9.6% apparently because of the shift in lattice. It may be concluded that the lattice form has no effect upon dielectric constant. (The influence of this change in lattice on loss angle was not investigated.)

During the measurements with cellulose J in the main apparatus, it was noted that the specimens adsorbed diffusion pump oil from the atmosphere even at 0.1

Table V. Dielectric Constant of Several Regenerated Cellulose Sheets

Cellulose	*Density*	ϵ	$\epsilon_{0.8}$	$\epsilon_{0.8}/2.4$	ϵ/ϵ_N[a]
J (solvent)	0.368	1.75	3.31	1.38	1.15
J (solvent)	0.538	2.30	3.45	1.44	1.26
J (solvent)	0.553	2.55	3.90	1.63	1.38
E (air dried)	0.518	2.08	3.09	1.29	1.17
J (ether)[b]	0.329	1.94	5.20	2.16	1.34
J (ether)[b]	0.335	1.85	4.37	2.36	1.27

[a] ϵ_N is ϵ of native cellulose sheet at the density of regenerated cellulose sheet.
[b] Dried by solvent replacement through ether.

Table VI. Dielectric Constant of Cellulose L

Specimen	Density, g/cc.	ϵ	$\epsilon_{0.8}$
L-1	1.50	4.27	2.16
L-2	1.43	3.37	1.99

mu pressure, a phenomenon not observed with any other cellulose. The oil could be easily removed with ether. Although it is possible that the presence of this oil could affect the loss angle determination, it is unlikely since oils generally possess low power factor and the amount present was negligible on a weight basis. Whether the surface activity demonstrated by these celluloses is the result of their high amorphous cellulose content or of their high specific surface is not known. They are definitely better absorbents than native cellulose.

It would appear that the cause of increased loss angle and dielectric constant of these celluloses is the increased content of amorphous cellulose. Examination of the loss angle curves shows that their shapes are similar to those of native cellulose. The increased values, as compared with native cellulose, might be explained by the fact that more hydroxyl groups are free to oscillate because they are no longer bound in a crystalline region, where the groups are close enough to permit hydrogen bonding to take place. Possibly portions of chains in the amorphous areas are free to oscillate. The observed increase in dielectric constant may be similarly explained. A similar increase in dielectric loss and dielectric constant with increasing amorphous content has been observed in the case of another linear polymer (polydecamethylene sebacamide) by Baker and Yager (*30*).

If these deductions are correct the dielectric constant of cellulose L, a cellophane having the same moisture regain as cellulose J and, presumably, a similar amorphous content, should show a similar increase. The results of two tests are presented in Table VI. Cellulose L does not show the expected increase in dielectric constant. It has been stored in formaldehyde solution. Formaldehyde is known to cause cross linkages in cellulose and it is possible that these linkages could cause a lowered dielectric constant. Stoops (*2*) found a dielectric constant of 7.9 for cellophane at 1000 cycles at 65 °C. If a density of 1.5 gram per cubic centimeter is assumed, a value of 3.0 at standard density may be calculated, definitely higher than native cellulose.

These celluloses possessed thermoplastic properties. Under moderate pressures they flowed and showed substantial increases in apparent density. This pressing caused definite changes in the electrical properties. A specimen of cellulose F was pressed at 2000 p.s.i. for 10 minutes at 110 °C., and tested. The loss angles at standard density at 1000 cycles are presented in Table VII together with comparative values for native cellulose and unpressed cellulose J.

Table VII. Loss Angle of Hot-Pressed Regenerated Cellulose at 1000 Cycles

Temp., °C.	$\epsilon'_{0.8} \times 10^3$, radians		
	Cellulose F (pressed)	Native cellulose	Cellulose J (unpressed)
25	2.60	2.80	4.78
50	1.55	1.70	2.60
75	1.90	1.62	2.45
100	3.75	2.13	3.08

Table VIII. Dielectric Constant of Hot-Pressed Regenerated Celluloses

Cellulose	Description	ϵ	Density, g./cc.	$\epsilon_{0.8}$	Moisture regain at 54% R. H.
J	Solvent dried, unpressed	1.75	0.37	3.31	11.6
J	Solvent dried, pressed	2.51	0.83	2.44	10.3
E	Water dried, unpressed	2.08	0.52	3.09	10.8
E	Water dried, pressed	1.86	0.68	2.07	10.0
J	Solvent dried, glycerin heated, unpressed	2.57	0.55	4.00	9.6
J	Solvent dried, glycerin heated, pressed	4.03	1.19	2.52	..
F	Air dried, pressed	2.54	0.98	2.15	10.0

Similar comparative results are found at other frequencies. The loss angle at lower temperatures is similar to that of native cellulose, but rises at higher temperatures. This rise may be partially explained by the presence of carboxyl groups in this cellulose. The dielectric constant is similar to that of native cellulose. The pressing has thus caused significant changes in dielectric properties.

The effect in the case of dielectric constant was confirmed by measurements in the auxiliary dielectric constant apparatus. Results of several experiments are reported in Table VIII. The pressing in each case has reduced the calculated dielectric constant to values similar to native cellulose.

It is possible that this treatment caused a partial reversion of amorphous regions to crystalline regions. This would account for the changes if the amorphous regions are responsible for the increase in loss angle and dielectric constant. Cold pressing of a specimen of cellulose J induced similar changes in the observed dielectric constant, as shown in Table IX. Even the short duration of the first pressing significantly reduced both the dielectric constant and the moisture regain.

Values of the dielectric constant computed to standard densities obtained in both apparatuses are presented as a function of moisture regain in Fig. 7. The mean value from Table IV at 65 °C. has been taken as the value for the main apparatus determinations. A direct relation between the two quantities is indicated. If Hermans is correct in correlating moisture regain and amorphous content, the dielectric constant may be regarded as a measure of the amorphous content.

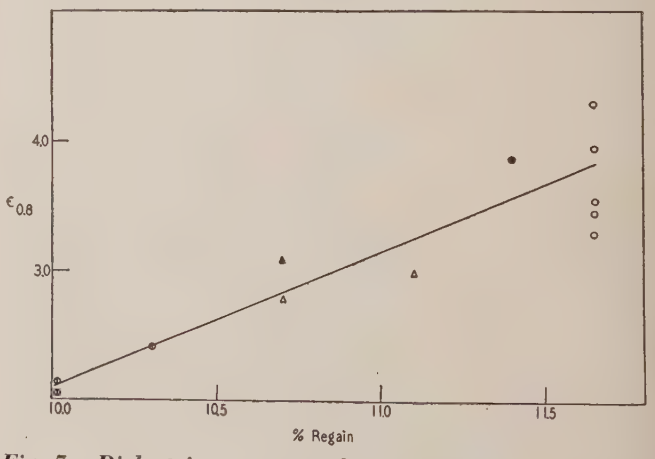

Fig. 7. Dielectric constant of regenerated cellulose as a function of moisture regain

○ J (unpressed); ● J (main apparatus); ① E, F, J (hot pressed); △ J (cold pressed); and ▲ E (unpressed).

Table IX. Dielectric Constant of Cold-Pressed Solvent Dried Cellulose J

Treatment	ϵ	*Density, g./cc.*	$\epsilon_{0.8}$	*Moisture regain at 54% R. H.*
Unpressed	2.39	0.537	3.57	11.7
Pressed 15 sec. at 2000 p.s.i.	2.67	0.712	3.01	11.1
Pressed 10 min. at 2000 p.s.i.	2.74	0.785	2.79	10.9

However, the data obtained with cellulose L (cellophane) are contradictory since, on the basis of its moisture regain, it is amorphous and yet it has a low dielectric constant.

The regenerated celluloses are of low density in general, whereas cellophane approaches the density of pure cellulose. It is possible that both the dielectric properties and the moisture regain are related in some way to the apparent density differences. These celluloses are probably filled with submicroscopic small voids. This concept readily explains the low density, the ease of compressibility, and the escape of cyclohexane. If the surfaces of these voids (e.g., individual molecular chains) contribute to the dielectric constant and loss by the presence of free hydroxyl groups, as previously discussed, the observed differences can be accounted for. In a high-density cellulose, like cellophane, the relatively close packing might prevent the oscillations of hydroxyl groups. However, this explanation would not explain the lowered moisture regain observed upon pressing. The moisture regain test has not yet been applied over wide humidity ranges and its exact meaning is not clear. The possibilities of interference in the case of the cellophane test have been pointed out. In view of these facts, no definite conclusions can be drawn.

SUMMARY

A test capacitor system has been constructed for use with a conjugate Schering bridge, incorporating several desirable features. With this apparatus, measurements of loss angle and dielectric constant can be made at temperatures from 25 to 105°C. *in vacuo* of the order of 0.1 mu. Considerable pressure can be exerted upon the specimen during testing for the purposes of eliminating error resulting from incomplete filling of the test capacitor.

An auxiliary apparatus for the rapid and reasonably accurate measurement of dielectric constant has been constructed.

The applicability of the Clausius-Mosotti relation to native cellulose has been confirmed.

The loss angle and dielectric constant of several native celluloses have been measured at 500, 1000, 2000, and 4000 cycles per second at temperatures from 25 to 105°C. No significant differences between different native celluloses were noted. Loss angle-temperature curves exhibited a minimum, the temperature of the minimum increasing with increasing frequency. Dielectric constant-temperature curves showed a slight minimum and rose slightly at higher temperatures. No frequency effect was noted. These observations may be adequately explained if cellulose is regarded as a heterogeneous linear polymer with many polar groups.

Similar measurements upon degraded native celluloses confirmed these relationships. The presence of carboxyl groups caused increased dielectric loss at higher temperatures, whereas carbonyl groups had little effect. The dielectric constant was not affected.

The loss angle and the dielectric constant of specially prepared regenerated celluloses were higher than corresponding values for native cellulose at all frequencies. The dielectric constant of cellophane, however, was comparable with that of native cellulose. Pressing of the regenerated cellulose specimens at moderate pressures caused a lowering of these values. A possible correlation between amorphous cellulose content and dielectric properties was found, but the evidence is conflicting and no definite conclusions can be drawn.

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Received March 30, 1950. Presented at the Annual Meeting of the Technical Association of the Pulp and Paper Industry, Commodore Hotel, New York, N. Y., Feb. 20 to 23, 1950. A portion of a thesis submitted in partial fulfillment of the requirements of The Institute of Paper Chemistry for the Degree of Doctor of Philosophy from Lawrence College, Appleton, Wis., June, 1949. This work was carried out under the direction of J. A. Van den Akker.

The Operation of the Multiroll Beater

MILTON R. ROBERTS

The beater type refiner is a triple roll beater in which the stock is treated continuously. The control is maintained through pressure adjustments of the bedplates. In the conventional batch system the bedplate is stationary with a small amount of roll pressure adjustment. In the triple roll beater the bedplates are supported during operation by six cylinders having from 0 to 300 p.s.i. pressure. Pressure variations have direct bearing on the effect of treatment. The stock flow is introduced through flow spreaders in front of the first roll. This level is constant during operation and safety features are incorporated in the design to prevent damage to the rolls or bedplates in event of flow failure. Tests conducted over a six-month period of operation show the beater to have the effect and flexibility for which it was designed. During the period of operation no apparent signs of wear are shown on the bars and no down-time was recorded due to maintenance. Data are given to substantiate the increase of quality due to the beater, and data from paper machine records prior to and after beater installation show difference in quality of paper made from beater treated fiber. Study of the 6-month operating period leads the writer to believe the use of the beater for treating southern kraft stock to be effective. Further studies under different conditions are to be made and presented to the industry at a later date.

In the past years no less than 25 beaters of various designs have been introduced to the market for treatment of fiber. Beaters have been used in most cases in a batch system in which the stock is rebeaten until the desired amount of work has been performed. Good control is one feature of such a system, but added cost in power consumption has led Southern mills to employ conical-type refiners as a means of treating pulp because of the reduced power cost. Freeness control, fiber length, and the use of handsheets evaluate the extent of work performed in any refining room operation. With few exceptions beaters have been of the single-roll type which are placed so that stock can be recirculated through the beater until the desired treatment has been obtained. The application of a continuous beating system has not been given much attention until recently. The introduction of a multiroll beater-type refiner has been made in order to accomplish better work on fiber and lower power consumption.

The multiroll beater was designed for mills where power is a critical item, but it has been installed in a kraft mill in the South to determine the possibilities in using such a machine in treating southern kraft fiber.

The machine differs from the ordinary beater in that its work is controlled by bedplate pressures, whereas in the other types, the control is by roll pressures. The triple roll arrangement was designed to attempt the replacement of conical refiners. In the period of operation the amount of treatment to the stock has been more than was expected. Maintenance of the unit and power savings are important points in evaluating this beater. The use of one such beater in a comparatively large mill will not complete the experimental picture. However, it is hoped that some gain in knowledge of multiroll beater operation has been made with this installation. The installation of the beater in a smaller capacity mill would have been better for experimental purposes.

Reduction in fiber length with a degree of fibrillation in the objective of any beating or refining system. The quality of paper produced from a furnish depends on these two factors. Beater stock is of high quality for one or more of several reasons: (1) better hydration control, (2) more uniform fiber length, (3) easy control of degree of beating, etc. Therefore, the need for beaters is emphasized even more as higher standards in paper quality are set. As stated before, the operation costs of batch systems are more than with conical or disk refiners. Hence the solution would be to have a beater which would do the work of a batch beater on stock at a power consumption equal or lower than that in the use of refiners in the process. Also continuity of treatment is desired in this beater the same as is found in conical refiner installations. Stock, which has been treated by the multiroll beater refiner, has the appearance of fiber stock treated by the single roll beaters. The uniform fiber length and the degree of fibrillation can be noted. It is the hope of many that the multiroll beater will be the initial step in the solution of the problem.

EQUIPMENT DESCRIPTION

The multiroll beater is composed of three rolls which are 66 inches in width and 54 inches in diameter. Each roll has 160 heat-treated steel bars $^1/_4$ inch thick with $^3/_4$-inch wood spacers. They operate at 150 r.p.m. Bedplates for the rolls are in three sections each, as can be seen in Fig. 1. Each of these sections consists of 12 heat-treated steel bars $^1/_4$ inch thick. They are set at an angle of 20° to the axis of the roll. The individual sections are removable and can be replaced in reversed order insuring longer working life of the bedplate. The hydraulic mechanism for placing the bedplate assembly against the roll consists of six hydraulic cylinders each being 6 inches in diameter and grouped in pairs. Control of these cylinders is maintained from a panel located near the machine. Since the control is operated from readings of p.s.i. cylinder head pressure, the control panel is equipped with both recording and direct-reading pressure gages. The oil lines are of $^1/_2$ inch inside diameter. The control valves are of a by-pass type making easy the adjustment of pressures. Six hydraulic cylinders have an area of 169.64 square inches. Assuming that a pressure of 100 pounds is being applied, a total of 16,964 pounds is exerted. The tare weight of the bed plate assembly is approximately

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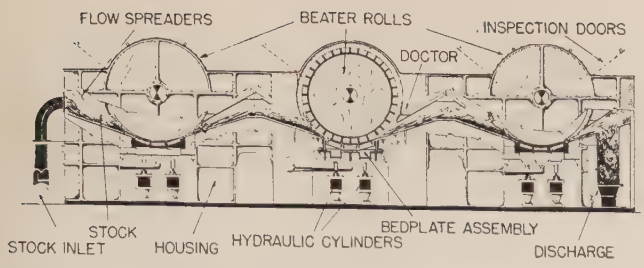

Fig. 1. Diagram of multiroll beater

5000 pounds. Therefore the actual pressure against the roll for the first 100 pounds pressure applied would be 11,964 pounds. Normal operating pressure range is 0 to 300 pounds and a maximum of 45,882 pounds can be safely applied against the beater roll. The contact area throughout which this pressure is being exerted is 138.25 square inches. Using this figure as contact area and assuming normal full load at 300-pounds pressure the theoretical pressure is calculated to be 331.9 p.s.i.

After having considered the bedplates and the roll, the determination of inch cuts per minute on the individual roll is computed as being 57,024,000. The total of 160-bars in the roll revolving at 150 r.p.m. against 36 bars in the bedplate gives the above figure.

Beaters using the heat-treated steel knives may, at some time, have grooving effects after long periods of operation. In order to eliminate this in the multiroll beater the entire roll is moved $^1/_2$ inch right and left by the use of an oscillating mechanism located on the side of the roll opposite the drive side. Evidence that this feature has a bearing on the treatment of the stock has been found: however, it is mentioned here only as a matter of interest. The objective is primarily to decrease grooving and maintain uniform knife conditions.

Each roll is driven by a 200-hp. motor. Belt drives are used on all rolls. Power failures can cause no damage to the rolls as the pressure is automatically released and the bedplate dropped in case of failures. This has been found to be true on instances where power failure was momentary.

The inside lining of the beater is stainless steel. The corners are blocked off to eliminate dead spots in the flow. A magnetic separator in the line just before the stock inlet was installed to insure removal of scrap metal. On occasions when this was examined bits of metal which may have caused damage to the beater rolls were found. Stock is pumped into the beater inlet through two 6-inch lines, 24 inches apart. The flow spreaders are designed to deliver the stock against the roll instead of forming a head at the inlet. A safety switch at this point prevents overflowing and insures clean equipment instead of a stock-covered housing. Adjustable trap doors are located behind each roll for the purpose of controlling recirculation of stock around the roll. Doctors are also located behind each roll as can be seen in Fig. 1. Doors are indicated in four places along the path of the stock flow for inspection of the interior and securing samples from the individual rolls.

OPERATION AND STOCK TREATMENT

Operation is comparatively simple and trouble-free to the refining-room engineers. When it is necessary to start up the unit the beater drive motors are switched on first, and the rolls allowed to rotate free of bedplate pressure. The stock pump is started and adjustments are made on the inlet line by use of a gate valve which regulates the flow to the front side of the first roll. The hydraulic pumps are started, and the bedplate of the first roll is put into position with a pressure not to excede the normal load. Then the second and third bedplates are put into use with the desired pressure. Familiarity with the action of the beater in treatment of stock is necessary in order to standardize beater settings for various types of paper. This involves a short period of careful experimentation on the stock using various settings. Normal efficiency was reached within six days after the beater was first put into operation.

The average permanganate number of the stock during the investigation was 32.5 TAPPI Standard. This was the average stock hardness to the paper machine at the time of the investigation. No work has been done on stock of different degrees of hardness. That phase of experimental work with the beater in kraft mills will be presented at a later date when opportunity to investigate is presented.

As a matter of interest the appearance of stock after it had passed each jordan in a series was noted. The work accomplished by these machines showed the progressive treatment throughout the series.

After passing through two primary jordans the feed stock to the multiroll beater was dumped into a chest from which the beater inlet lines originate. The normal level of the chest is approximately 10 tons air-dry pulp. It was noticed that some of this stock had been treated but only in a primary manner. The freeness decrease from the raw stock was found to be an average of 47 ml. total for the work of both refiners. The screened stock to the primary jordans had an average initial freeness of 720 ml. (Green).

Examination of the stock after the first roll of the beater with 125 pounds pressure being applied to the bedplate showed some difference as portions of the fiber appeared flattened and beaten near the ends. With 175 pounds pressure applied to the second roll the resulting stock treatment showed considerably more beaten fiber and flattening. The third bedplate had 225 pounds pressure applied, and the stock possessed a well-rounded appearance of partially beaten fiber. At 300 pounds pressure it was noted that broken fibers were being produced and although this operating pressure is within range from the standpoint of load, slight overtreatment was observed. After receiving additional treatment at the final jordans this stock was lowered in freeness to 320 ml. (Green). Recirculation of stock around the roll of the beater did not account for the overtreatment as this condition doesn't exist at lower pressures.

During the first month of operation freeness checks were made after each roll six times daily, and handsheets were prepared in accordance with TAPPI Standards. It was found that the freeness averaged 673 for unbeaten stock introduced at the inlet of the beater. After the first roll the freeness average for the period was 639 ml. or a difference of 34 ml. for the 125 to 150 pounds applied pressure. After the second roll the freeness average recorded was 577 ml., a difference of 62 ml. in comparison to the stock on the front side of the roll. The combined work of both rolls gave 96

ml. decrease in freeness. At the discharge of the second roll the sample collected had been subjected to 175 to 200 pounds additional pressure. This difference in pressure plus rebeating accounts for nearly twice as much work being accomplished at the second roll. The third roll was operated during the period of investigation with bedplate pressures of 225 to 250 pounds. The freeness decrease averaged 94 ml. due to the work of the third roll. Thus the unbeaten stock was lowered in freeness a total of 190 ml. on the three rolls. Microscopic examination of fiber was made periodically so that it would be assured the decrease in freeness was not due to cutting. Fiber length classification would have been more helpful in this phase of the investigation.

The above results were obtained with the beater operating at an average of 25.5 amp. The top load on the drive motors was 28.8 amp. The beater stock was used in a mixture with the regular type refined stock as a furnish to the paper machine, and from computations, it was assumed that the beater was handling more than $^1/_3$ of the daily tonnage or 70 to 80 tons daily during the trial period. This stock was introduced at $3^1/_2\%$ consistency. The method of determining the capacity was by measurement of chest levels and not by flow meters which are usually employed for obtaining data on capacities.

The inch cuts per minute were being produced regardless of the type stock being introduced or the consistency of the stock. It was found that although consistencies below 3% had the same freeness drop as had higher consistencies the practice of keeping consistencies adjusted to 4.0 to 4.5% is most practical and economical. To conserve power when using such type of installation the operator must have good control on his stock consistencies so that no power is wasted. At the plant where this experimental work has been carried on it was necessary to increase consistencies throughout the refining room in order to operate with high-consistency stock through the beater. Therefore opportunity to observe operations at varying consistencies was afforded.

In comparison with refiners of the conical type it has been observed that the multiroll continuous beating system is superior. Data to support this observation were taken from both power distribution and refining room records. A series of tests were made with only the conical-type refiners in process operation and a comparison showed power savings up to 35% with the beater. By the addition of 600 hp. in the multiroll beater it was possible, on some runs, to eliminate 900 hp. in other refiners, meaning a 300 hp. savings while maintaining a product of higher quality in the daily production.

Decrease in freenesses of 30 ml. for the work of 300 hp. on the daily production were found to be the normal average of the other refiners.

An increase in quality and production was obtained with the beater in the system: lightweight papers had the largest percentage increase—on some runs this figure exceeded 12%.

The bursting strength was of more interest than the other tests usually performed on handsheets, and tests on beaten stock showed an average increase of 35% over unbeaten stock during a period of three months operation. On some pulps the strength development was greater. The tensile strength increased an average of 3.9 pounds (1-inch wide test strip). The tensile strength before beating averaged 16.3 pounds and after beating, 20.2 pounds. In many cases the tear tests made on handsheets did not change, however, an average of 7 grams decrease in tear for the beaten stock was found over the operating period. The unbeaten tear test averaged 122 grams.

It was interesting to compare the appearance of handsheets made from beaten stock with those of the unbeaten stock. The absence of shives and slivers could be particularly noted.

Some changes were made on the machine after installation but the results of stock treatment apparently were not different from those mentioned. It was found that a single multiroll beater does not have the capacity for treating all the stock in a mill of 180 tons daily production to effect a continuous beating system.

The further collection of data and more study is necessary over a longer period to present a clearer view on the maintenance costs and wearing of moving parts. However, after six months of almost continuous operation the total wear of knives on the roll and bedplate is only $^1/_8$ inch. No other checks have been made as inspections of other parts would have required more down time.

Received Jan. 10, 1950. Presented at the Annual Meeting of the Technical Association of the Pulp & Paper Industry, New York, N. Y., Feb. 20–23, 1950.

DISCUSSION

H. Vranian (The Chesapeake Corp. of Va.): Have you any figures on the horsepower consumption for any one grade of paper?

M. Roberts (Hudson Pulp & Paper Co.): No, since we change grades quite often; once it was as high as 12 times in the one day.

Mr. Vranian: Your installation consists of primary jordans, then through the multiroll refiner, and on to the paper machine?

Mr. Roberts: No. We have two primary jordans, the multiroll beater, a recirculation back through the multiroll beater, followed by five jordans, and a final treatment in three tickler jordans.

S. L. Foster (Kalamazoo Vegetable Parchment Co.): How much connected horsepower do you have on your jordans?

Mr. Roberts: 300 hp.

Mr. Foster: What is your daily production?

Mr. Roberts: One hundred and sixty tons per day to the paper machine, but it will depend on the treatment required as to what proportion of our total production goes through the multiroll beater.

A. P. Yundt (Camp Manufacturing Co., Inc.): In line with the mentioned savings in horsepower, have you considered slowing down the beater? In the case of jordans isn't approximately 75% of maximum power consumed even if the jordan plugs are completely backed off? And with lower speeds, is not the power consumption lowered to a considerable extent?

Answer from floor: If the speed of the jordans is lowered, the horsepower usage goes down in the ratio of the cube of the speed. I agree with Mr. Yundt that we should use twice as many jordans at one half present speed for a real saving in operating and useful power consumption.

Electronic Water Penetration Tester

P. E. MARENHOLTZ

The current practice of making water penetration tests by means of the dry indicator method has been found to be unsatisfactory both from the standpoint of accuracy and convenience. More accurate test methods have been developed, but a simpler and faster method is needed. The electronic water penetration tester was developed in an effort to answer these needs. It provides an automatic means of registering the time required for water to penetrate a specified depth into the board. The electrical conductivity of the penetrating water is utilized to close an electric circuit. A needle acting as an electrode is inserted into one face of the sample to such a depth that its point is a specified distance from the opposite face which is exposed to water. The instrument is provided with a running time meter which is started at the beginning of the test. At the instant the penetrating water reaches the needle point, the running time meter stops and a signal light in the instrument is turned on to indicate that the test is complete. This instrument and method offer the advantage of being entirely automatic after the test is started. The final meter reading may be taken at any time after the test is complete.

THE development of the water penetration tester was carried out in an effort to arrive at a dependable water penetration test method which can be performed with a minimum of personal attention and skill. It was thus hoped to overcome the principle disadvantages of the methods used for these tests.

It is the current practice to make water penetration tests by means of the dry indicator method in accordance with the Federal Specification LLL-F-321b adapted from TAPPI Standard 433 m. The validity of this method was tested in the course of work done at The Institute of Paper Chemistry under Project 1116 sponsored by the Insulation Board Institute (*1*). It was found that the test did not give a true measure of the time of transudation of water when applied to wood-fiber board. In this work tests were made by the dry indicator method and at the time when complete penetration was indicated the test was stopped and the actual depth of penetration was determined by measuring the moisture content of the specimen in different layers cut parallel to the surface which had been exposed to water. These measurements indicated that the water had actually penetrated only a fraction of the thickness of the board so that the results of the dry indicator test may be in error by several hundred per cent. This error was found to be the result of the sensitivity of the indicator to water vapor which penetrates at a greater rate than does the actual liquid water.

In further work done at The Institute of Paper Chemistry (*2*) a test was developed to give a positive indication of the actual depth of penetration of water after a given period of exposure. In the new test developed by the Institute the sample is prepared by cutting to a 6-inch square size and applying wax to the edges to insure that water enters the sample only through the exposed face. The sample is then exposed to water by being supported in a bath with its bottom face about $^1/_8$ inch below the surface. The temperature and level of the water must be controlled. Since the test is intended to be an accelerated method elevated water temperatures are used: 130° F. was recommended as a suitable temperature for the test. After exposure for a given period of time the sample is cut in sections by means of a band saw. The cut edge is observed and the actual depth of penetration is measured with a ruler. A water-soluble fluorescent dye may be applied to the edge to more clearly indicate the cross sectional area that has been moistened with the water. This is readily observed when the sample is studied under ultraviolet light.

Progress Report No. 2 (*2*) of The Institute of Paper Chemistry gives measurements of depth of penetration to an accuracy of $^1/_{16}$ inch. The author's experiments also showed that after careful cutting with a fine-toothed band saw the accuracy of measurement was limited to $^1/_{16}$ inch because of the fuzziness of the line of demarcation between wet and dry material. When studying penetration to a depth of $^1/_8$ inch, this accuracy allows an error of 25 to 50%, depending on the skill of the observer.

In order to overcome these disadvantages, it was thought necessary to provide a means of determining the depth of penetration without the necessity of cutting the samples for observation. It appeared that this could best be accomplished by an electrical means. Taking account of the fact that ordinary water is a conductor of electricity because of the small amounts of salts and impurities it contains, a system was set up whereby the water which penetrates the board acts as a conducting medium to close an electric circuit and give an indication when the water has penetrated to a given depth. This is done by inserting a needle into the dry face of the sample to such a depth that its point is a specified distance from the wet face. This needle then acts as one electrode and the tank containing the water bath acts as the other electrode. It was found necessary to use a very small sharply pointed needle. The use of an ordinary straight pin resulted in considerable decrease in the running time of the test. The water is the conducting medium and the circuit is completed at the instant the penetrating water reaches the point of the needle. Reference to Fig. 1, the schematic diagram of the tester, will show how this external circuit is used to indicate the end-point of the test. The instrument includes a triode-type vacuum tube with a sensitive relay in its plate circuit. The potential on the cathode of the triode is held at about 50 volts above B- by the action of the voltage divider made up of the resistances R_1 and R_2. Before the external circuit is completed, the potential on the grid of the triode is B- since the grid is returned to B- through the current limiting resistor R_5 and the resistance, R_3. This means that the grid is be-

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low cutoff so that there is no plate current flowing through the triode and consequently the relay in its plate circuit is not energized. It will be noted that power is supplied through the normally closed relay contacts to an elapsed time meter which is installed in the instrument and through the normally open contacts to the red

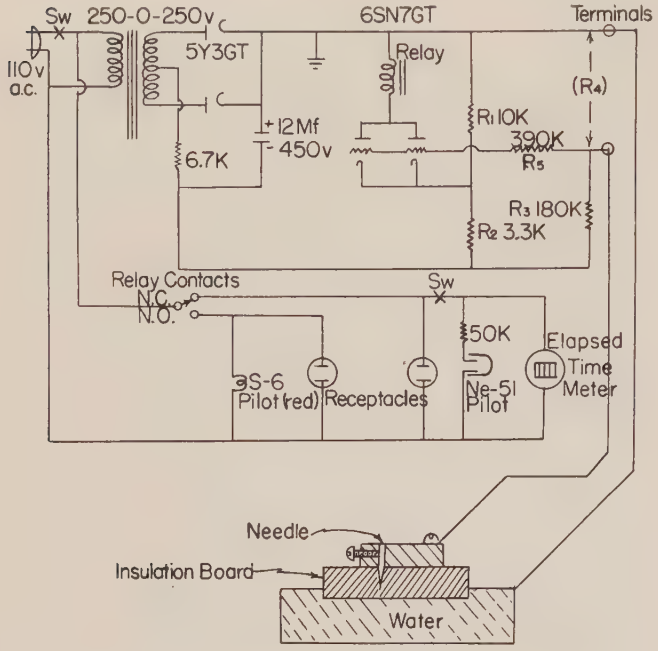

Fig. 1

pilot lamp. When the end point of the test is reached, the external circuit acts as a resistance which is represented by (R_4) and forms a voltage divider in conjunction with R_3. The values of R_3 and (R_4) are such that the grid potential of the triode rises to the cathode potential causing the triode to conduct and energize the relay. This causes the elapsed time meter to stop and turns on the red pilot lamp which serves as a signal that the end point of the test has been reached. The duration of the test is indicated by the difference between the readings of the elapsed time meter before and after the test. The final reading may be taken at any time after the red pilot lamp is observed to be burning.

A series of tests on several different brands of insulation board were conducted in order to check the performance of the instrument and to determine the variation of water penetration resistance as a function of the water temperature. The samples were prepared by waxing the edges as in The Institute of Paper Chemistry tests. In all tests, measurement was made of the time required for the water to penetrate to a depth of $^1/_8$ inch. Operation of the instrument was found to be quite simple and no technical troubles appeared throughout the course of the tests. The instrument would be especially well suited for use in control testing because of the simplicity of operation. For example, it may be determined that a routine test regularly runs between 3 and 4 hours. Then it would only be necessary to change the sample and take the reading at 4-hour intervals. An additional advantage is the fact that a test could be left running over night because once the end point of the test has been reached, the meter reading remains unchanged until the sample is removed.

The results of several tests are presented in the form of curves in Fig. 2, in which the test duration is plotted against the water temperature for each of the boards tested. It has been noted that in some types of board, the water does not penetrate evenly but may reach a depth of $^1/_4$ inch at some points, while going in only $^1/_8$ inch at other points. This is the principal cause of the unevenness in some of the curves in Fig. 2. In order to make more accurate tests on these samples it may be necessary to average readings taken at several different points on the sample. All these tests could be run simultaneously by using several instruments or a single instrument provided with several complete channels. Tests have not yet been conducted at temperature below 100°F., but it appears that the higher temperatures must be used if a reasonable advantage is to be gained through accelerating the tests.

If smooth curves are drawn through the points the maximum deviation of any single point from the curve is found to be about 25 to 30%. In other words, a single test with a single needle can generally be expected to produce a value that will be within 30% of the average many readings. By careful adjustment the needle can be inserted to a specified depth with an accuracy of about 0.01 inch, or less than 10% for $^1/_8$ inch measurements. As the number of tests is increased, the accuracy

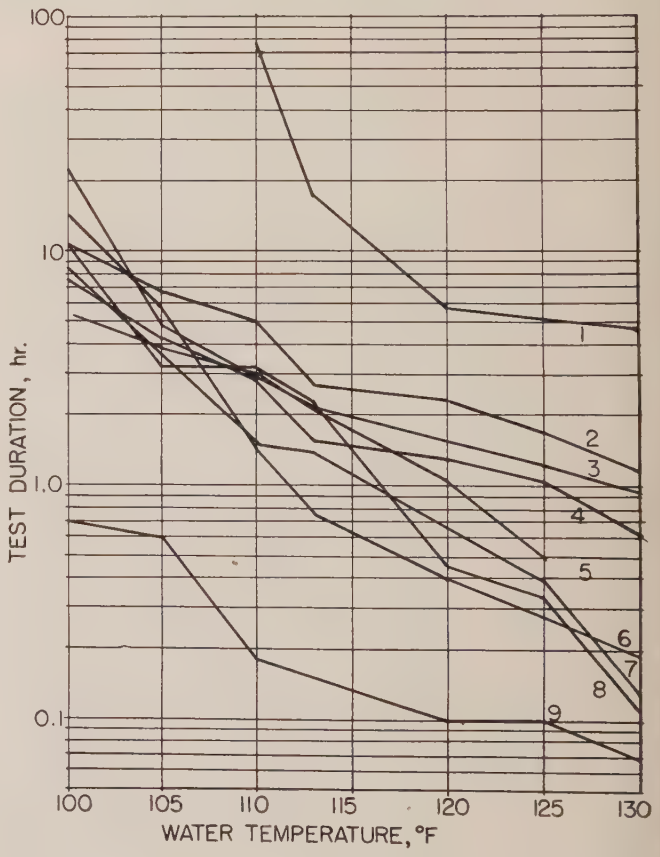

Fig. 2

of the average result approaches this value (10%). It therefore appears that a worth-while improvement in the instrument will result from equipping it to make a number of tests simultaneously as previously suggested.

The results of many of the tests thus far conducted have been checked by noting the depth of the penetra-

tions of the liquid water at the end of the test. In all cases, the water had actually penetrated to the needle point. Further experiments were conducted by measuring the electrical resistance through the board in the external circuit of the tester after a long enough exposure to indicate failure by the dry indicator method. This was found to exceed 100,000,000 ohms. The instrument is triggered when the resistance in the external circuit falls below 250,000 ohms. In view of this great difference between the resistance of wet material and that of material at high-moisture content there is little reason to fear that the instrument cannot be made to operate without being triggered by water vapor.

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Received Jan. 31, 1949. Presented at the Annual Meeting of the Technical Association of the Pulp & Paper Industry, Hotel Commodore, New York, N. Y., Feb. 21–24, 1949.

Performance of Paper Machine Wet Felts

I. Preliminary Microscopic Observations of the Effect of Microorganisms on the Plugging of Felts

STANLEY J. BUCKMAN

A method is described for embedding specimens of paper machine wet felts which is an adaptation of a similar method employed for textiles. The felt specimens were embedded within 1 hour after removal from the paper machine, or were refrigerated until embedded, to prevent any significant additional growth of microorganisms. The only treatment of the felt specimens prior to embedding consisted of removal of excess water by pressing the specimens between pieces of blotting paper. Deposits in the used wet felts were preserved in the state in which they existed at the time of removal from the paper machines by impregnation of the specimens with a low viscosity solution of methyl methacrylate monomer, plasticizer, and catalyst followed by heating at 53°C. to polymerize the resin. Sections 30 mu in thickness were prepared for microscopic examination with a sliding microtome. Unstained sections were mounted directly in Canada balsam and safranin stained sections were mounted in the same medium after a minimum of preparatory treatment. Comparison of unstained and stained sections showed the deposits in the felts were not significantly disturbed by the staining procedure which aided in differentiation. Sections from used wet felts employed during the production of newsprint, kraft, and fine papers showed the presence of masses of capsulated bacteria which filled the spaces between the felt fibers to varying degrees. Photomicrographs of a number of sections are presented. The study is being extended to include a large number of used wet felts which have been employed for the production of different kinds of paper under the range of conditions encountered in the paper industry.

The general relationships in the removal of water from fiber and other components of paper furnish have been reviewed in a recent thought-provoking paper by Sankey and Cowan (*5*). The paper included a discussion of the flow box and slice, drainage of stock on the wire, the press section and the drier section. Although properly recognizing the importance of the art of papermaking and not desiring to detract from it, particular attention was directed to the chemical engineering principles involved in the problems of materials separation on a fourdrinier paper machine. Emphasis was placed on the need for full cooperation between technology and art in most efficiently meeting the challenging problems encountered in the operation of a machine of major economic significance.

The amount of water removed from the sheet in the press section is relatively small in comparison to the amount removed at the table rolls, suction boxes, and couch in the wire section of a fourdrinier machine. However, it is difficult to overemphasize the need for proper functioning of the press section prior to the much more costly operation of removing a comparable or smaller amount of water by evaporation in the driers. Garrett (*3*) has presented an excellent paper on the press section of a newsprint machine giving the results of a study of suction presses and their relation to drying paper. The paper covered the relationships between water removal in the press section and press roll crown, distribution of load, suction box adjustment, and the distribution of the open area of a felt as influenced by uniformity of travel across the width of the felt. As Garrett noted, the operation of the press section is accompanied by many conditions which tend to produce unevenness in the distribution of moisture across the width of the sheet. In addition to the difficulties of delivering a sheet containing either a uniform moisture content across its width or a moisture content increasing uniformly from the center to the edges of the sheet, the press section is often called upon to deliver a sheet containing other distributions of moisture to match with, or compensate for, still other defective conditions of the preceding or succeeding sections of the machine.

The possible relationship between the presence of microorganisms in felts and the amount as well as the uniformity of water removal in the press section has received very limited attention. It is well known that a number of microorganisms are present in paper machine systems and in wet felts which will attack

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The expression "wet felts" is used in this paper to cover both wet and press felts.

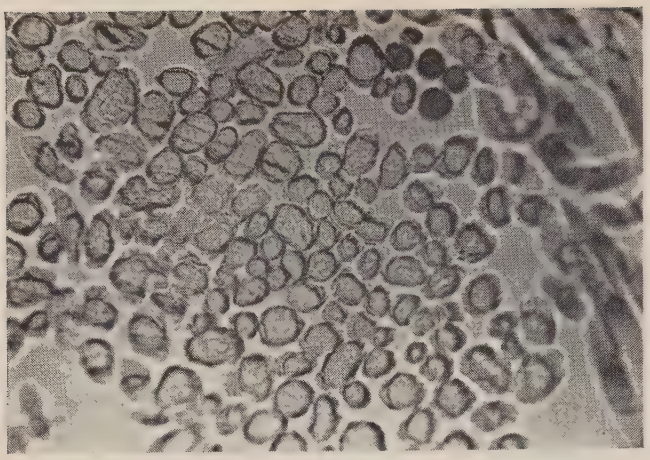

Fig. 1. Unstained section of a new felt

and thereby weaken the woolen fibers under favorable growth conditions. Race (*4*) has presented the results of a recent study on this subject as well as a review of earlier work including that of Appling, Smith, and Fronmuller (*1*) and Smith (*7*). Shema and Appling (*6*) also recently reported that the use of safranin stain is helpful in detecting attack of wool fibers by microorganisms. However, as far as the author is aware, there is no published information on the degree to which microorganisms contribute to the plugging of water-removing felts by their presence alone and as a binder for other materials. Since slime control in some paper machine systems to a degree which yielded virtually a slime-free condition seemed to result in more effective and more uniform action of wet felts a systematic study was started to obtain further information. The present paper describes the method employed to embed used paper machine wet felts to preserve the deposits in the state in which they existed at the time of removal from the paper machine as well as the initial results obtained from sectioning and microscopic study of several representative felts.

METHOD OF EMBEDDING

The method described is an adaptation of one which has been employed for embedding textiles (*2*). The adaptation has been found suitable for embedding felts of paper machines so that they can be sectioned with a microtome for microscopic study of the deposits in the felts. The procedure was designed to preserve the deposits in the state in which they existed in the felts when removed from the paper machines and prevent subsequent growth of microorganisms in the felts.

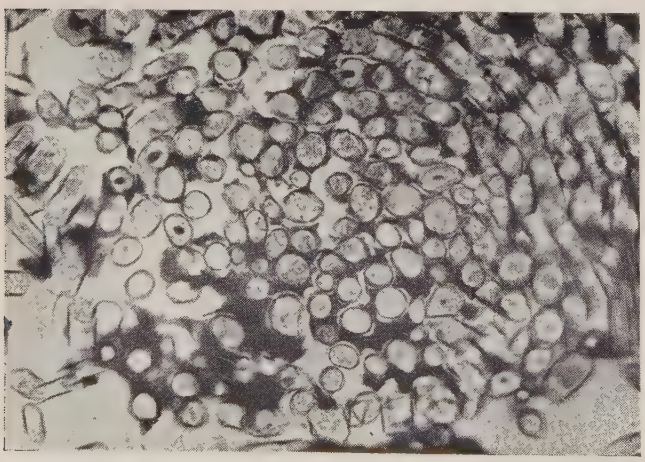

Fig. 2. Stained section of a used first press felt from a fourdrinier paper machine making newsprint showing deposits of capsulated bacteria between the felt fibers

Resin Embedding Medium

The resin embedding medium consisted of a resin monomer, methyl methacrylate monomer from Rohm and Haas Co., Philadelphia, Pa.; a plasticizer, methyl phthalyl ethyl glycollate (Santicizer M-17) from Monsanto Chemical Co., St. Louis, Mo.; and a catalyst, benzoyl peroxide, in the following proportions:

Methyl methacrylate monomer	150 ml.
Santicizer M-17	88 ml.
Benzoyl peroxide	0.5 gram

The mixture was freshly prepared each day, felt samples were embedded or a stock supply was prepared in advance and stored in a closed bottle in a refrigerator to prevent polymerization prior to use.

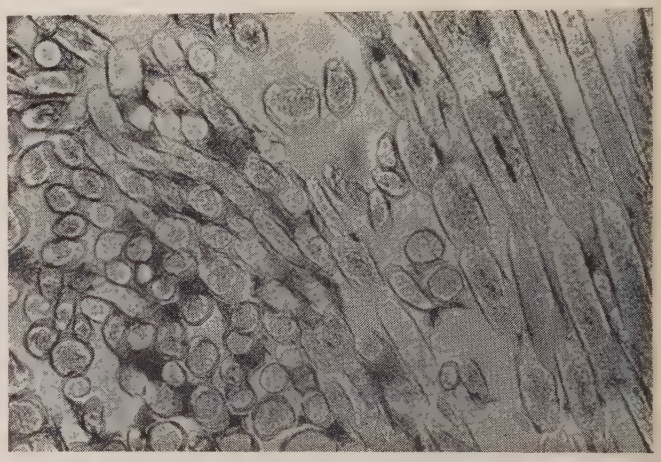

Fig. 3. Unstained section of a used first press felt from a fourdrinier paper machine making kraft paper showing deposits between the felt fibers composed largely, if not entirely, of capsulated bacteria

Embedding Mold

Gelatin capsules, size No. 11 labeled "Empty Gelatin Capsules for Veterinary Use" from Parke, Davis and Co., Boston, Mass., were used as embedding molds.

Procedure

Specimens were cut from the felts and immersed in the embedding medium within 1 hour after the felt was removed from the paper machine or the felt specimens were placed in a refrigerator within 1 hour and embedded not more than 48 hours later. The felt specimens for embedding were 1.4 cm. wide and 3.5 cm. long and were cut from the felt so that the longer measurement was parallel to the length of the felt. In general, two specimens were obtained from each felt. When there seemed to be any evidence of a difference, one specimen was cut from an area which was believed to be comparatively open and one from an area which was believed to be comparatively plugged. Before immersion in the resin embedding medium, excess water was removed from the felt specimens by pressing between two pieces of blotter paper.

The capsule used as an embedding mold was placed in a hole drilled part way into a cork to hold it upright

during assembly and subsequent heating. The top was removed and the larger bottom portion of the capsule was filled to within 5 mm. of the top with the embedding medium. A drafting pin slightly longer than the top part of the capsule then was slowly forced through the top of the capsule and into one end of the felt specimen for a distance of about 5 mm. after which the specimen was inserted into the liquid embedding medium by placing the top of the capsule over the bottom to close it in the normal manner. The top of the capsule was gradually pushed over the bottom to the maximum extent possible to prevent appreciable evaporation of the low boiling portion of the monomer which would leave a softer resin than desired. As the top of the capsule was pushed down over the bottom, the felt specimen was manipulated with side and vertical movements of the pin to keep the sides of the specimen approximately centered between the walls of the capsule and the top of the felt specimen flush with the top of the bottom portion of the capsule. If the felt specimen showed a significant tendency to twist or curl when first placed in the embedding medium, it was removed and straightened by hand one or more times as necessary. After final adjustment the excess length of pin was allowed to protrude from the top of the capsule and a piece of pressure-sensitive tape was wrapped around the protruding portion to prevent subsequent downward movement of the pin and felt specimens impaled on the end of the pin inside the capsule. The cork holder, capsule, and contents then were placed in an oven and heated for 24 hours at 53 ± 2° C. to polymerize the resin. A 24-hour heating period usually was adequate to produce a resin that would not flow when the capsule was placed in a horizontal position for 1 hour. However, if this test indicated that polymerization was not complete, heating was continued for another 24 hours or longer at 53°C. since continued heating does not harden the resin beyond a desirable point.

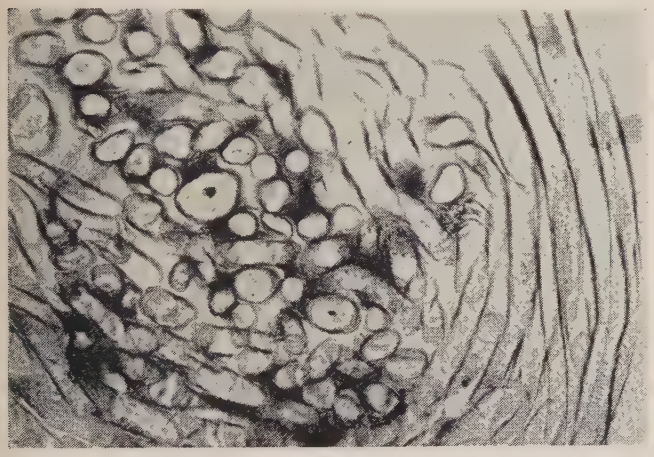

Fig. 4. Stained section from close to the same position in the same felt from which the unstained section shown in Fig. 3 was obtained

SECTIONING AND MICROSCOPIC EXAMINATION

Prior to sectioning, the gelatin capsule was removed from the cylinder of polymerized resin by soaking in hot water followed by scraping and the cylinder trimmed to the desired size. The trimmed block of resin then was surrounded by paraffin to increase the rigidity of the block and sections 30 mu in thickness were prepared with a sliding microtome. Unstained sections were mounted directly in Canada balsam. Sections for staining were fastened to the slides with a thin layer of albumin and dried, after which they were dipped for 0.5 minute in a solution of 2% safranin in 50% alcohol, dried for several minutes and the excess stain removed by washing with 95% alcohol. They then were air dried until all of the liquid disappeared from the section, a drop of Canada balsam was placed on the section, cover glass added and the slide dried for 12 to 24 hours on a warming table at about 45°C. Comparison of stained and unstained sections showed that the staining procedure did not significantly disturb the felt fibers or the deposits between the fibers. Since the safranin stain aided in differentiation most of the sections were stained prior to examination.

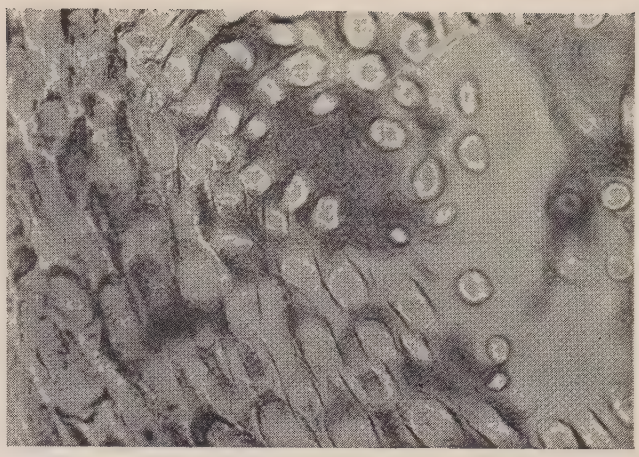

Fig. 5. Stained section from another position in the same felt from which the sections shown in Figs. 3 and 4 were obtained

Note the deposits composed largely of masses of capsulated bacteria filling a large proportion of the space between the felt fibers.

Figure 1 shows a photomicrograph of an unstained new felt which is presented as a general basis of comparison with photomicrographs from several representative used felts shown in Figs. 2–6.

Figure 2 shows the deposits found in a first press felt of a fourdrinier machine making newsprint. The felt was placed on the machine on July 4, 1949, and was

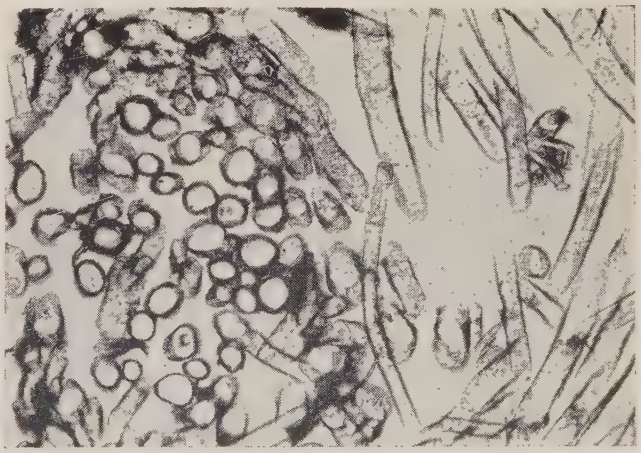

Fig. 6. Stained section of a used first press felt from a fourdrinier paper machine making fine paper showing deposits composed of capsulated bacteria and probably filler particles

removed on July 17, 1949. The felt was subjected to the action of one suction roll during its life. The felt shower water applied intermittently was chlorinated and slime control chemicals were being used in the paper machine system. The furnish consisted of unbleached groundwood and sulphite pulp with no size or alum being employed. A pH of about 5 was maintained with sulphuric acid and the temperature of the system was 100 to 108°F.

Figures 3 to 5 show the deposits found in a first press felt of a fourdrinier machine making kraft paper. An unstained section is presented in Fig. 3 while Fig. 4 shows a similar section after staining. The section shown in Fig. 5 was from another position in the same felt specimen. The quite heavy deposits found in all of the sections and, particularly the one shown in Fig. 5, contained a high proportion of capsulated bacteria. In this respect, it is of interest to note that the felt specimen was taken from an area of the felt which appeared to be plugged. The felt was placed in operation on Sept. 21, 1949, and was removed on Oct. 3, 1949, which was regarded as a good comparative performance. The felt was subjected to the action of one suction roll and to a suction-type felt conditioner. Felt showers were applied intermittently with no treatment in the shower water. Chemicals were being added to the paper machine system to control slime. The furnish was all unbleached sulphate pulp with rosin size and alum. The temperature of the system was 110 to 120°F. and the pH was 5.0 to 5.5.

Figure 6 shows the deposits which accumulated in a first press felt of a fourdrinier machine making fine paper. Capsulated bacteria were present in the deposits, and a significant proportion of filler also may be involved. The felt was placed on the machine on Oct. 12, 1949, and was removed on Nov. 6, 1949. The felt was subjected to the action of one suction roll and a suction-type felt conditioner during its life. Chemicals were added to the paper machine system to control slime during the life of the felt. The furnish consisted of bleached spruce, poplar, and jack pine pulp with rosin size and alum and a filler composed of clay, Calopone, and titanium dioxide. Sveen glue also was added to the system which was operated at a temperature of 75 to 80°F. and a pH of about 4.8.

The conditions shown by the photomicrographs are believed to be reasonably typical of those existing in many wet felts based on the examination of a number of additional felt specimens. Although further work must be done before general conclusions can be made, it is difficult to see how the spaces between the felt fibers can be filled to the observed degrees without reducing the water-removing effectiveness of the felts. It thus seems probable that microorganisms play a more important role in this respect than has been generally realized and a potentially fruitful field for further work is indicated. The study is being extended to include a large number of used wet felts which have been employed for the production of different kinds of paper under the range of conditions encountered in the paper industry.

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The author is indebted to the staff members of a number of cooperating paper mills who have embedded felt specimens and to Clyde M. Christensen and David W. French, Division of Plant Pathology and Botany, University of Minnesota, St. Paul, Minn., for their helpful work on the preparation of sections and slides showing the deposits in the specimens.

An Instrument for Rapid Fractionation of Pulp

ARTHUR E. REED and JAMES d'A. CLARK

The new four screen classifier developed by Clark is described and its operating procedure given. This instrument divides a 5-gram sample of pulp into four fractions plus debris, in 4 minutes. Reference is made to the method of calculating the weighted average fiber length by weight of a pulp sample from classifier data. This method was published earlier and is not repeated in detail. The operating conditions and the weighted average fiber length of the fibers in each fraction were determined experimentally using Clark's projection method. These fiber lengths were as follows: On 14, 3.85 mm.; $^{14}/_{28}$ 2.70 mm.; $^{28}/_{48}$ 1.70 mm.; $^{48}/_{100}$ 0.95 mm.; through 100, assumed 0.10 mm. The distribution of fiber lengths was plotted to verify the above method. It was found that in this classifier the weighted average fiber length by weight in each fraction was 8% greater than the arithmetical average fiber length. Mill data are presented to demonstrate the usefulness of this instrument and method in pulp refining studies.

From the point of view of both the paper machine operator and the investigator, fiber length is one of the more obvious and important characteristics of pulp or paper stock.

Apart from visual observations of the fiber length obtained by breaking apart a piece of moist pulp, by greatly diluting the pulp with water and observing it against a dark background, as on a blue glass, or by using the microscope or a projector; one of the first special instruments for fractionating pulps according to length, was a beater knife devised nearly 50 years ago by Schulte. It consisted of a blade about a foot long and about $^1/_4$ inch thick at its handle, tapering almost to nothing at its tip. By cutting through diluted

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James d'A. Clark, Research Development Engineer, Longview, Wash.

stock fibers are caught on the tapered edge and, the longer the fibers, the nearer the handle the fibrage forms. A similar principle was employed by R. A. Webber (U. S. pat. 1,786,973) to selectively separate long fibers from a pulp suspension, by Schlick (*1*) with his grid used to obtain an index of the fiber length of stock, and more recently by Montigny and Zbrowski (*2*) who adapted a special grid to the TAPPI or British Standard sheet machine to obtain a similar index.

The Hurum flour tester (*3*) was an early screening instrument, followed with the use of special flat screens by a number of investigators in United States and Canada around 1930.

A great step forward was made when the late Harold T. Ruff designed the prototype of the Bauer MacNett classifier, the first efficient instrument. A year or so later, the Johnson fiber classifier was evolved at the Pulp and Paper Research Institute of Canada. In 1936 Clark designed an instrument in which the screens instead of the pulp suspension were rotated. The Clark two-screen classifier (*4*) embodying this principle was commercially available the following year.

NEW FOUR SCREEN CLASSIFIER

Ten years later Clark designed and tested the new four screen instrument shown in Fig. 1. The instrument is of very simple construction and may be operated as one, two, three, or four screen classifier. It consists of a semicircular tub divided into four main compartments, in each of which is an open circular screen 13 inches in diameter mounted on and driven by a common shaft rotated at about 48 r.p.m. by a geared motor. The construction of each screen is similar to that of a bicycle wheel, the wire screen taking the place of the spokes. The rim of each screen consists of an annular brass strip which forms a seal by rotating between the longitudinally slit edges of a piece of soft rubber tubing mounted in a small metal channel on the inside of the tub.

By means of a constant headbox, water is passed through the classifier at a chosen rate of 12.5 liters per minute. In each compartment the incoming water is directed to the bottom of the tub by means of a weir and baffle. The consequent motion of the water serves to keep the fibers from settling and to present them regularly to the rotating screen through which they will pass if their length is less than twice the screen opening. So effective is the design that if a squirt of dye is added to the incoming water in the first compartment, there is no trace of color in the first compartment after 1 minute, nor in the last compartment after 4 minutes.

When classification of a sample is complete, the pulp held in each compartment (or that in the first compartment only if so desired) is drained and washed onto a 200-mesh stainless steel wire screen affixed by a bayonet joint to the bottom of each drain box. These fiber pads, together with a pad prepared from a duplicate of the

Table I. Effect of Time of Classification on the Percentage and Length of Fibers Caught in Each Compartment

				Raw pulps						Refined pulp			
		A	B	C			D			E			
Time, min.	*Fraction*	*Fiber length, mm.*	*Fiber length, mm.*	*Fiber length, mm.*	*Percentage By weight*	*Product Lx, %*	*Fiber length, mm.*	*Percentage By weight*	*Product Lx%*	*Fiber length, mm.*	*Percentage By weight*	*Product Lx%*	*Average fiber length, mm.*
4	Long	..	3.85	3.96	60.8	2.42	3.84	58.6	2.26	3.87	54.6	2.11	3.85
	Medium	..	3.11	2.73	21.7	0.60	2.73	21.6	0.59	2.67	20.0	0.53	2.70
	Fine	..	1.71	1.71	11.7	0.20	1.72	12.0	0.21	1.71	11.8	0.20	1.70
	Very fine	..	0.98	0.95	3.8	0.04	1.01	4.0	0.04	0.92	4.4	0.04	0.95
	Debris	..	..	0.1	2.0	..	0.10	3.8	..	0.10	9.2	0.01	0.10
				Wtd. Av. Fib. Lgth. $\overline{3.26}$ mm.			Wtd. Av. Fib. Lgth. $\overline{3.10}$ mm.			Wtd. Av. Fib. Lgth. $\overline{2.89}$ mm.			
5	Long	3.90	4.10	4.03	55.0	2.22	..	..	..	3.88	48.9	1.90	..
	Medium	2.86	3.33	3.17	24.0	0.76	..	..	..	2.71	20.6	0.56	..
	Fine	1.87	2.01	2.00	13.0	0.26	..	..	..	1.69	13.0	0.20	..
	Very fine	1.06	1.05	1.17	4.4	0.05	..	..	..	0.95	4.4	0.04	..
	Debris	..	..	0.1	3.6	..	..	..	..	0.10	14.2	0.01	..
				Wtd. Av. Fib. Lgth. $\overline{3.29}$ mm.						Wtd. Av. Fib. Lgth. $\overline{2.71}$ mm.			
6	Long	3.98	4.10	4.26	52.0	2.21	..	..	..	3.88	45.0	1.76	..
	Medium	2.91	3.33	3.24	25.6	0.83	..	..	..	3.12	21.8	0.66	..
	Fine	1.83	2.23	1.94	12.4	0.26	..	..	..	1.74	12.6	0.22	..
	Very fine	1.05	1.07	1.01	4.8	0.05	..	..	..	0.95	4.8	0.04	..
	Debris	..	..	0.10	4.0	..	..	..	..	0.10	15.8	0.02	..
				Wtd. Av. Fib. Lgth. $\overline{3.35}$ mm.						Wtd. Av. Fib. Lgth. $\overline{2.70}$ mm.			
7	Long	4.02	..	..	..	..	..	..	..	4.03	41.4	1.68	..
	Medium	3.01	..	..	..	..	..	..	..	2.94	23.3	0.68	..
	Fine	1.96	..	..	..	..	..	..	..	1.73	13.4	0.25	..
	Very fine	1.14	..	..	..	..	..	..	..	0.89	5.0	0.05	..
	Debris	..	..	..	..	..	..	..	..	0.10	17.0	0.02	..
										Wtd. Av. Fib. Lgth. $\overline{2.68}$ mm.			
10	Long	4.46	..	..	..	..	..	..	..	..	..	..	..
	Medium	3.25	..	..	..	..	..	..	..	..	..	..	..
	Fine	2.12	..	..	..	..	..	..	..	..	..	..	..
	Very fine	1.19	..	..	..	..	..	..	..	..	..	..	..
	Debris	..	..	..	..	..	..	..	..	..	..	..	..

pulp added to the classifier, are squeezed between blotters, dried (preferably on a hot plate) and weighed.

Speed of Operation

By virtue of the streamlined flow of the passing water, the new instrument will fractionate a sample of pulp satisfactorily into four fractions (plus debris) in less than 5 minutes as compared with about 15 minutes or longer with previous classifiers. If only the first fraction is required—the most informative one—it can be isolated satisfactorily with the new instrument in $1^1/_2$ minutes. Thus, accurately determining the percentage by weight of the long fibered fraction of a sample of pulp takes no more than a minute longer than either a freeness test or the approximate method using the grid of Schlick or de Montigny and Zbrowski.

Operating Results

When a fiber suspended in water approaches an opening in a screen moving relatively rapidly across the direction of flow, it can pass through the opening if its length is less than twice the greatest dimension of the opening. Large fibers will pass through the screen if the fibers are very flexible or curled. The chance collision of a fiber on the square opening of a wire mesh allows the passage of a rigid fiber of a length equal to about twice that of the diagonal if it is so presented. On the other hand, if the fiber collides across the corner of an opening, the passage of even a short fiber will be temporarily stopped. The effect of this and the curl of the wet fibers, make quite a wide distribution of fiber lengths in any one compartment unavoidable. As fractionating is continued, additional fibers (mostly the shortest ones) will pass from a compartment and will be replaced in part by fibers coming from the preceding compartment (mostly relatively long ones). Thus both the quantity of fibers caught in a compartment and their average length will depend somewhat on the time of classification.

Table II. Distribution of Fibers in Each Compartment and Average Lengths

Raw pulp C			*Refined pulp E*		
(A) Percentage of fibers in range	Product AB, mm.	Range, mm.	(B) Av. length of range, mm.	(A) Percentage of fibers in range	Product AB, mm.
First Compartment (on 14-Mesh)					
3	5	1.5–2.0	1.75	4	7
14	32	2.0–2.5	2.25	13	29
14	38	2.5–3.0	2.75	11	30
15	49	3.0–3.5	3.25	17	55
21	79	3.5–4.0	3.75	19	72
12	51	4.0–4.5	4.25	18	77
10	47	4.5–5.0	4.75	8	38
7	37	5.0–5.5	5.25	5	26
2	11	5.5–6.0	5.75	3	17
1	6	6.0–6.5	6.25	2	12
1	7	6.5–7.0	6.75	...	...
100	3.62			100	3.63
Av. from total measured length: 3.67 + 8% = 3.96 mm.				Av. from total measured length: 3.58 + 8% = 3.87 mm.	
Av. from balance length: 3.86 mm. = 3.62 + $6^1/_2$%				Av. from balance length: 4.05 mm. = 3.63 + 11%	
Second Compartment (on 28 Through 14-Mesh)					
4	5	1.0–1.5	1.25	9	11
15	26	1.5–2.0	1.75	19	33
32	72	2.0–2.5	2.25	32	72
23	63	2.5–3.0	2.75	20	55
15	50	3.0–3.5	3.25	14	46
8	30	3.5–4.0	3.75	3	11
2	8	4.0–4.5	4.25	3	13
1	5	4.5–5.0	4.75	...	...
100	2.59			100	2.41
Av. from total measured length: 2.53 + 8% = 2.73 mm.				Av. from total measured length: 2.47 + 8% = 2.67 mm.	
Av. from balance length: 2.80 mm. = 2.59 + 8%				Av. from balance length: 2.60 mm. = 2.41 + 8%	
Third Compartment (on 48 through 28-Mesh)					
10	7	0.5–1.0	0.75	8	6
42	53	1.0–1.5	1.25	49	61
28	49	1.5–2.0	1.75	26	46
15	34	2.0–2.5	2.25	12	27
4	11	2.5–3.0	2.75	3	8
1	3	3.0–3.5	3.25	2	7
100	1.57			100	1.55
Av. from total measured length: 1.58 + 8% = 1.71 mm.				Av. from total measured length: 1.59 + 8% = 1.71 mm.	
Av. from balance length: 1.75 mm. = 1.57 + 11%				Av. from balance length: 1.60 mm. = 1.55 + 4%	
Fourth Compartment (on 100 through 48-Mesh)					
5	1	0.0–0.5	0.25	9	2
68	51	0.5–1.0	0.75	61	46
23	29	1.0–1.5	1.25	28	35
4	7	1.5–2.0	1.75	2	4
100	0.88			100	0.87
Av. from total measured length: 0.88 + 8% = 0.95 mm.				Av. from total measured length: 0.85 + 8% = 0.92 mm.	
Av. from balance length: 0.92 mm. = 0.88 + 5%				Av. from balance length: 0.90 mm. = 0.87 + 3%	
From above, weighted average length by weight taken as approx. average meas. length + 8%					

Table I shows the result of several experiments on the effect of time on the average length and on quantity of southern pine pulp caught in each of the compartments. It will be observed that after about 4 minutes, the average length of both the raw and the beaten pulps are about the same in any one compartment. From this and a number of other experiments, a classification

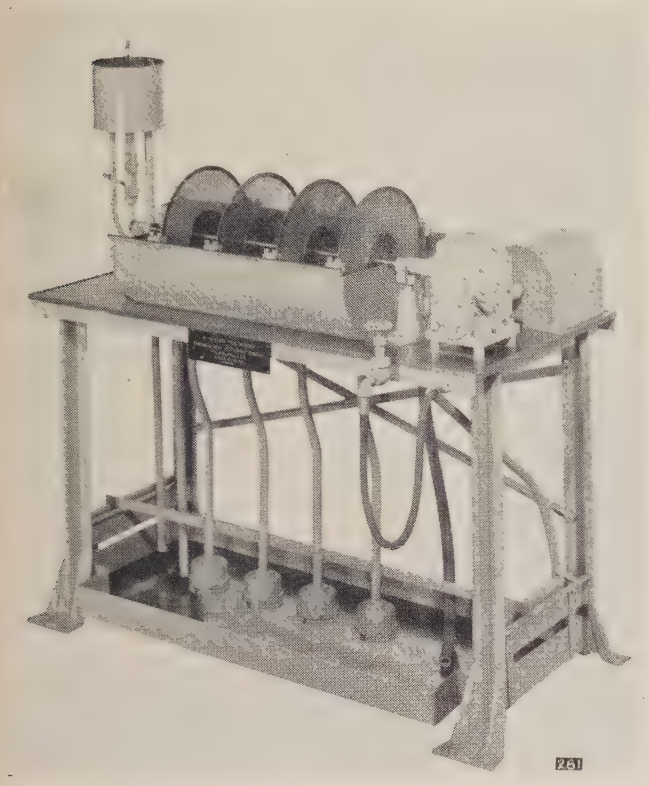

Fig. 1. Clark four-screen classifier

time of 4.0 minutes was chosen for a 5-gram sample with a series of screens having 14, 28, 48, and 100 meshes and a water flow of 12.5 liters per minute.

An important conclusion in accordance with theory and confirmed by Table I is that provided the appropriate weighted average fiber lengths are found for each fraction for the instrument and classification conditions used, the weighted average fiber length of the whole pulp is probably independent of the kind of classifier used or of the method of its operation, within reasonable limits. This provides a basis for standardizing the determination of the weighted average length of a sample of pulp independently of the kind of equipment available.

With the present equipment and chosen conditions; 5-gram pulp sample, 12.5 liters per minute and a classification time of 4 minutes, the following average constants apply for the weighted average fiber lengths in each compartment: On 14, 3.85 mm; $^{14}/_{28}$, 2.70 mm; $^{28}/_{48}$, 1.70 mm; $^{48}/_{100}$, 0.95 mm; through 100 (debris), assumed 0.10 mm.

The length of the "on 14" fraction will vary with the kind of wood used for the pulp and needs to be determined for every species. On the other hand, the factors for the intermediate fractions, are not expected to change appreciably for any kind of pulp, beaten or unbeaten. When the projection equipment is set up, it is not difficult, nor does it take much time to determine the weighted average length of the fibers in a sample by the method described by Clark (*5*); but as stated, after the factors are once determined there is no need to make further fiber measurements.

Distribution of Fiber Lengths in Each Fraction

The length of the individual fibers in each of the fractions of raw pulp C and refined pulp E in Table I, were picked off the working charts of the projected fiber lengths, and placed into their corresponding 0.5-mm. ranges as shown in Table II. If the quantity of water flowing through the instrument is reduced to say 5 liters per minute and the time of flow extended to say 10 minutes, sharper classification of the fibers may be attained. However, for the most purposes, the extra time involved is not justified.

It will be seen that the distribution of the fibers in the corresponding fractions for the raw and the refined pulps is quite similar. It will also be noticed that the calculated average lengths of the fibers in each fraction by this procedure compare quite closely with the actual average lengths of the fractions obtained by dividing the total length of all the fibers by the number in accordance with the above method (*5*).

With fiber measurements, greater accuracy of the average length determination may be quicker and more easily achieved by measuring a large number of fibers

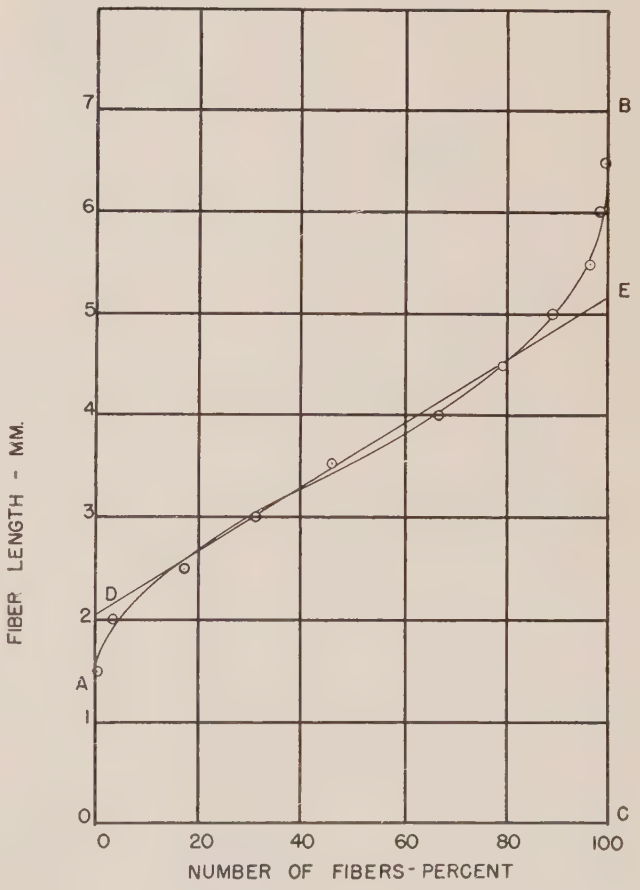

Fig. 2. Distribution of fibers in 14-mesh fraction

with a fair accuracy—say to the nearest 0.1 mm. than by measuring fewer fibers with greater accuracy. This is true provided, of course, that no systematic error is made in the method; as, for example, by improperly measuring the actual degree of magnification.

To convert the arithmetical average fiber length of a fraction of pulp in the classifier to the weighted average fiber length by weight—a very useful and significant value—it has been suggested (*5*) that with Bauer McNett fractions, an approximate conversion may be made by adding $12^1/_2\%$ to the arithmetical average fiber length as determined from fibers over 0.1 mm. in each compartment. With the new classifier, as may be seen from Table II, the amount to be added to the arithmetical average fiber length is approximately 8%.

On Fig. 2, from data given in Table II, 100 representative fibers from the long-fibered fraction of pulp C are figuratively laid side by side like a closed picket fence, in order of increasing length. The area OABC was actually cut out in a corresponding figure and the position of the center of gravity of this cut-out area was found by balancing it on a pin. In the case of this fraction, the position of the centroid was found to lie on the vertical line drawn through 59%. Next, a straight line D E was drawn fairly through the intermediate points of the curve. The line 59% cuts line D E at 3.85 mm. This is the direct experimentally determined weighted average fiber length of the fraction by weight, assuming all the fibers in the fraction have the same weight per unit length. Actually the weight per unit length is usually a little greater for the

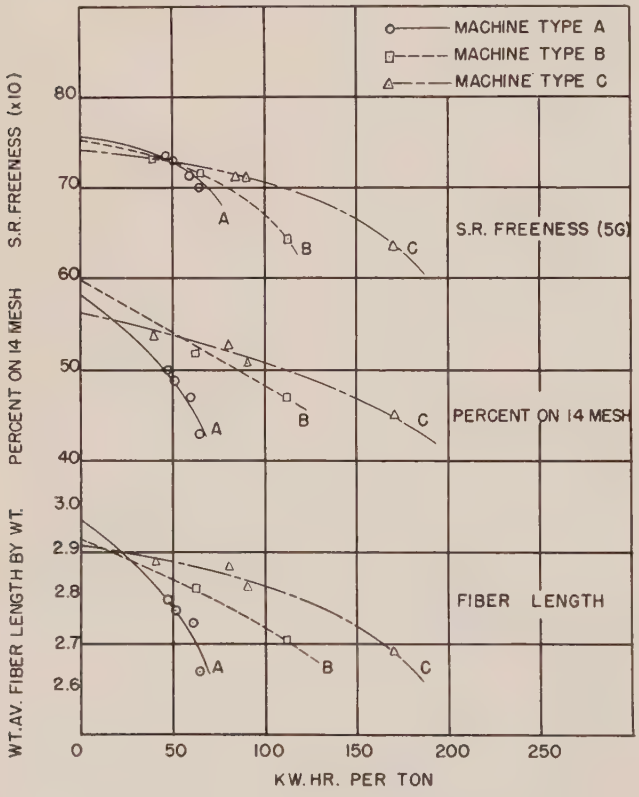

Fig. 3. Comparison of refining data

longer fibers so that the true weighted average length by weight of the fraction would be a trifle more than 3.85 mm. The arithmetical mean length of the fibers over 0.1 mm. in this fraction as actually measured, is 3.54 mm. which is about 9% less than 3.85 mm. However, the distributions of all the fractions given in Table II were similarly plotted, cut out, and balanced with the results given. It will be noticed that the addition of 8% to the measured numerical average fiber lengths in each instance brings the result very close to the experimentally determined weighted average fiber length by weight.

BEATING CONTROL

Using three different kinds of mill refiners working on unbleached southern pine kraft, the kilowatt hours per ton of pulp treated, the percentage caught on the 14-mesh screen, the weighted average fiber length by weight of the pulp determined in accordance with the foregoing instrument and method, and the freeness determined with a Schopper Riegler (5-gram sample at 20°C.) were measured. The data are given in Table III and the results plotted on Fig. 3.

Table III. Effect of Power Consumption on Per Cent in Coarse Fraction, Fiber Length, and Freeness

Machine type	*Power, Kw.-hr./ton*	*Per cent on 14 fraction*	*Length of whole pulp, mm.*	*Freeness, ml. S.R.*
A	0	58	2.96	753
A	46	50	2.80	733
A	50	49	2.78	731
A	59	47	2.75	716
A	63	43	2.64	700
B	0	60	2.92	750
B	62	52	2.82	719
B	111	47	2.71	642
C	0	57	2.92	745
C	39	54	2.88	732
C	79	53	2.87	715
C	88	51	2.83	711
C	169	45	2.69	633

It will be seen that the percentage of the long fraction of each sample was quite as sensitive a measure as was the freeness test for determining the degree of treatment to the pulp. In the case of machine types A and B, the freeness vs. power curves almost coincide, but the long fraction vs. power curves are very different. Machine B under the conditions used was the better machine. At 60 kw.-hr. per ton machine B gave a stock with a breaking length (TAPPI Standard) of 7300 meters; whereas, after the same power consumption, machine A gave a stock which had a breaking length of only 6800 meters.

With the new instrument a determination of the percentage of long fibers in a stock sample takes no more time than does a freeness test. There is thus provided a quick, reliable, and basically accurate measure of the progress of beating or refining based on the reduction in length of the fibers. The authors believe that the measuring of this property yields data which is of importance in completely analyzing and comparing the action of beating and refining equipment.

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Received Feb. 1, 1950. Presented at the Annual Meeting of the Technical Association of the Pulp & Paper Industry, New York, N. Y., Feb. 20–23, 1950.

The authors wish to express their appreciation to the Gaylord Container Corp. for permission to publish the data contained in this report, and especially to W. F. Gillespie under whose direction this work was conducted.

The Significant Chemical Components of Western Hemlock, Douglas Fir, Western Red Cedar, Loblolly Pine, and Black Spruce

HARRY F. LEWIS

A study has been made of the chemical components of selected samples of Douglas fir, western hemlock, western red cedar, black spruce, and loblolly pine. Douglas fir and loblolly pine are characterized by higher alpha-cellulose and lower hemicellulose B contents than are the other three woods. The three western woods are lower in pentosan than is the case with the spruce and pine. An unusually high percentage of the uronic acid content of the Douglas fir remains in the alpha-cellulose isolated from that wood. Western red cedar is characterized by the high lignin content of the extractive-free wood and by the high extractive content of the wood.

THE work reported at one of the sessions of the 1949 Fall TAPPI meeting covered information developed during the course of a research project set up by the Crown Zellerbach Corporation at The Institute of Paper Chemistry early in 1945 and carried out jointly since that time by the staffs of both groups. The purpose of the project was to develop basic information with reference to the chemical and morphological characteristics of important pulpwoods and the relationship between these characteristics and the properties of the pulps produced from the woods. Specifically the project was intended to explain the chief causes for the difference in kraft pulps obtained from Douglas fir and western hemlock. The reports are published in the Feb. 1950 issue of *Tappi,* pages 92 to 112.

Five woods were selected for the study—namely, Douglas fir (*Pseudotsuga taxifolia*), western red cedar (*Thuja plicata*), western hemlock (*Tsuga heterophylla*), loblolly pine (*Pinus taeda*) from the south, and eastern black spruce (*Picae mariana*) from the Lake States area. The wood samples used for these analyses were obtained as follows:

Western hemlock—Siltcoos area near mouth of Umpqua River	Crown Zellerbach Corp.
Douglas fir—Willamette Valley	Crown Zellerbach Corp.
Western red cedar—north fork of Lewis River, north of Kalama, Washington	Crown Zellerbach Corp.
Loblolly pine—eastern North Carolina	North Carolina Pulp Co.
Black spruce—probably from Canada, area of the Soo	Interlake Mill of Consolidated Water Power & Paper Co.

The western samples were obtained from typical sound logs, specially chipped and air-dried at Camas, Wash. One half of the chips were sent to the Institute for chemical and physical testing, the other half were reserved by the Crown Zellerbach Corp. for pulp studies. The samples for analytical evaluation were prepared as follows. On arrival of the western samples at the Institute, approximately 15 pounds of the chips were taken by grab from the various bags and put through the hammer mill. This material was then ground in the large Wiley mill to pass a 40-mesh screen.

The two eastern species arrived at the Institute in the form of 8-foot rough logs; they had been selected as typical of mill-run material. There were 32 sticks of black spruce and 12 sticks of loblolly pine. These sticks were sawed in half and one half was shipped to Crown Zellerbach Corporation for pulping studies. Sawdust for analytical purposes was obtained as follows: the bark was removed for about 4 inches at the end of the sticks at the Institute, taken from the center of the original logs, and an equal number of saw cuts were made from each piece to give a composite sample. This sawdust was air-dried and then ground in the Wiley mill to pass a 40-mesh screen.

The aim of the chemical work was to determine the relative amounts of significant components. The determinations for extractives included solubilities in ether, alcohol, acetone, and water. Determinations were made for ash, acetyl, nitrogen, methoxyl, lignin, methoxyl in lignin, tannin, and the following carbohydrate components: uronic anhydride, pentosan, mannan, hemicellulose A, hemicellulose B, alpha-cellulose, and pentosan, mannan, and uronic anhydride in the alpha-cellulose.

In general, TAPPI methods were used for the determination of the usual constituents of the wood. The values for hemicelluloses A and B and for alpha-cellulose were estimated by the Wise chlorite method as described by Wise, Murphy, and D'Addieco (*1*), and modified for the individual woods. The unextracted wood sawdust was chlorited four times (1 hour each time) at 70 to 80°C. in the usual manner with acetic acid and sodium chlorite. The resulting holocellulose was extracted successively for 2 hours at 20°C. under nitrogen with 5% potassium hydroxide and 24% potassium hydroxide, and the respective hemicellulose fractions A and B were recovered by precipitation with acetic acid and alcohol. These fractions are corrected for sulphated ash calculated arbitrarily as potassium acetate. The ash on the cellulose fractions

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The following members of the Institute staff participated in this study: E. Anderson, F. E. Brauns, B. L. Browning, M. A. Buchanan, P. F. Cundy, H. F. Lewis, E. K. Ratliff, and L. E. Wise.

Table I. Chemical Composition of Selected Pulpwoods[a]

	Douglas fir		Western hemlock		Loblolly pine			Spruce		Red cedar	
	1, %	2, %	1, %	2, %	1, %	2, %		1, %	2, %	1, %	2, %
Solubilities											
Ether	1.05	...	0.73	...	2.7	...	Water	3.28	...	7.33	..
Alcohol	3.81	...	3.9	...	1.14	...	Ether	0.63	...	0.31	...
Acetone	0.02	...	0.07	...	0.02	...	Alc.	0.96	...	2.56	...
Water	1.04	...	0.59	...	0.56	...					
Total extractives	5.92	...	5.3	...	4.4	...		4.9	...	10.2	...
Incidental determinations											
Ash	0.28	...	0.47	...	0.27	...		0.34	...	0.24	...
Acetyl	0.57	0.59	1.15	1.21	1.05	1.11		1.07	1.13	0.48	0.53
Nitrogen	0.04	0.04	0.1	0.11	0.05	0.05		0.04	0.04	0.1	0.11
Pentosan	7.3	7.8	9.2	9.7	11.7	12.2		12.3	12.9	9.25	10.3
Xylan (corrected for uronic anhydride)	5.8	6.2	6.9	7.3	9.6	10.1		10.0	10.5	7.27	8.1
Uronic anhydride	2.63	2.8	4.74	5.0	3.6	3.8		3.9	4.1	3.77	4.2
Methoxyl in wood	4.38	4.42	5.17	5.0	4.81	4.9		5.3	4.75	6.1	5.58
Lignin	26.7	28.4	28.8	30.4	28.3	29.5		26.7	28.0	29.3	32.6
Methoxyl in lignin	...	15.2	...	15.3	...	15.1		...	15.3	...	15.6
Tannin	0.5	...	...	...	0.1	...		...	...	1.5	...
Mannan	5.1	5.4	3.9	4.1	4.5	4.7		7.6	8.0	4.6	5.1
Pectic acid	0.43	...	0.45	...	0.34	...		0.64	...	0.11	...
Hemicellulose A (ash-free)	9.5	10.1	8.5	8.9	11.8	12.4		11.7	12.2	9.2	10.2
Hemicellulose B (ash-free)	3.8	4.0	6.2	6.6	2.8	2.9		4.9	5.1	4.0	4.5
Alpha-cellulose	53.8	57.2	48.8	51.6	52.6	55.0		49.0	51.5	47.5	52.8
Alpha-cellulose uronic acid anhydride	4.4		3.3		3.7			2.1		2.4	
Alpha-cellulose pentosan	1.8		2.0		3.1			1.9		1.7	
Alpha-cellulose xylan	1.7		1.8		2.8			1.7		1.5	
Alpha-cellulose mannan[b]	10–9		8–9		9–9			7–7		6–7	
Mannan in wood	5.4		4.1		4.5			8.0		5.1	
Uronic anhydride in wood	2.8		5.0		3.8			4.1		4.2	
Uronic anhydride in alpha-cellulose	2.5		1.7		2.0			1.1		1.3	
[Uronic anhydride in alpha/uronic anhydride wood] × 100	90.0		34.0		53.0			27.0		31.0	

(1) Original moisture-free wood basis.
(2) Extractive-free moisture-free wood basis.
[a] A portion of this material has already been published in an article by Wise and Ratliff [*Anal. Chem.*, 19: 459 (July, 1947)].
[b] Represents determinations made on separately isolated alphas.

was negligible. In the case of loblolly pine and Douglas fir, it was necessary to pre-extract with alcohol and ether before chloriting. Western hemlock was first hammer milled and screened, because the Wiley-milled material presented filtration difficulties.

Mannan in wood was determined by the tentative American Chemical Society method with the following modifications: (1) the chlorite holocellulose from 5 grams of wood was used as the sample; (2) the solution was kept hot during the addition of the barium carbonate cream; (3) the resulting suspension of sugar and barium sulphate was diluted to 2 liters (plus 40 ml. to compensate for the volume occupied by the barium carbonate), filtered, and the total volume of the filtrate measured and used as an aliquot of the original 2 liters of suspension; (4) the precipitate was allowed to form for 48 hours; and (5) after the precipitate had stood for the required 48 hours, the clear supernatant liquid was decanted through the IG-3 filter, 75 ml. of ethanol saturated with mannose phenylhydrazone were added to the flask, the contents were swirled several minutes, and finally filtered.

A detailed description of the steps followed in isolating the pectic substances in the five woods will be found in an article by Anderson (*2*). Essentially, the method involved the extraction of holocellulose by ammonium hydroxide; these extracts were decolorized with bromine and were then separated by treatment with calcium chloride into calcium pectate and hemicellulose.

The determination of the extractive material was combined with the preparation of extractive-free material for further analysis. Two pounds of the wood meal were extracted successively with ether, alcohol, acetone, and water at 60°C. In the case of spruce and cedar, the wood meal was extracted successively with water, ether, and alcohol.

EXPERIMENTAL RESULTS

The results of the various estimations will be found in Table I. In all cases—except for the extractives, mannan, tannin, wood methoxyl, the hemicelluloses, and alpha-cellulose—the estimations were made on the extractive-free material and calculated back to the original wood. With one exception, other determinations made on the original wood were calculated to the extractive-free basis. The one exception is the determination of methoxyl in the wood which was run on both original and extracted wood.

Summative analyses have been tabulated for the five woods, using for this purpose the values for the total extractives, lignin, hemicellulose A, hemicellulose B, alpha-cellulose, ash, and acetyl. These seven values are believed to cover the various components. The results, as shown in Table II, are very satisfactory.

Table II. Summative Analyses of the Five Woods

Percentages	*Spruce*	*Loblolly pine*	*Western hemlock*	*Douglas fir*	*Red cedar*
Total extractives	4.90	4.40	5.30	5.92	10.20
Lignin	26.70	28.30	28.80	26.7	29.30
Hemicellulose A	11.70	11.80	8.50	9.50	9.20
Hemicellulose B	4.90	2.80	6.20	3.80	4.00
Alpha-cellulose	49.00	52.60	48.80	53.80	47.50
Ash	0.34	0.27	0.47	0.28	0.24
Acetyl	1.07	1.05	1.15	0.57	0.48
	98.61	101.22	99.22	100.57	100.92

The chief difference between the fir and the pine, on the one hand, and the other three woods appears to be the lower hemicellulose B and greater alpha-cellulose contents of the former. The three western woods are also low in pentosan content.

Another difference not too easy to understand is the lower uronic anhydride content of the fir and the pine and the greater percentage of this appearing in the alpha-cellulose fraction.

The latter observation seemed so peculiar that a special investigation was made of the uronic acid determination as applied to wood and alpha-cellulose using Douglas fir. The net result of the experimental work to date is that, in this wood at least, either the uronic acid component of the wood is bound in part to lignin by a linkage resistant to hydrolysis by strong acid or it is located in such a position in the wood as to evolve carbon dioxide with difficulty. There is no evidence pointing to the formation of carboxylated oxidation products from the chlorite action since essentially the same results were obtained from the conventional holocellulose from fir.

The high lignin content of 32.6% on the extractive-free western red cedar is to be noted. A high yield of native lignin has also been observed from this wood. Western red cedar resembles redwood in its high lignin content and in certain other respects.

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Received July 29, 1949. Presented at the Fall Meeting of the Technical Association of the Pulp and Paper Industry held at the Hotel Multnomah, Portland, Ore., Sept. 12–15, 1949.

White Water Recovery by a Flotation Method

Operation of the Sveen Pedersen Saveall

PAUL EASTON and ROBERT BAUM

The theory of operation of the Sveen Pedersen flotation saveall is briefly discussed. Efficient reclamation of papermaking fibers and raw materials from white waters is obtained by dissolving air in the process flow under pressure and its subsequent release to atmosphere. The air is allowed to come out of solution attendant to induced flocculation of fibers and raw materials by suitable colloidally active flocculation aids. The flotation force obtained by this means enables high density recovery of raw materials for return to process. Clarified water is withdrawn from below the floated fibers and is suitable for showers, to enable conformance with pollution regulations, and other uses. The effect of proper flocculation of materials to be separated by the dissolved air process is discussed, and its role in attaining efficient flotation described. It is suggested that papermaking fibers in water suspension follow certain phenomenon common to carbohydrate colloids, and their flocculation may be economically controlled by colloidally active materials such as glue, silica, resins, etc., in amounts as low as a few parts per million.

In its simplest form the theory of the Sveen Pedersen saveall is based on the flotation principle. Fiber and filler in paper mill white water is aerated under pressure, given retention time to attain air in true solution, passed through a distributing valve to atmospheric pressure, and treated with a Sveen glue solution, activated silica sol, and/or other suitable flocculants, etc. The white water is then allowed to pass quickly into an area of low velocity where the fiber and filler float to the surface from which it is recovered by positive action scrapers. The white water is thereby clarified and passes out from the bottom of the unit.

The flotation is accomplished by release of gases (usually air) from the particles being separated and from solution in microscopic bubbles. This occurs over the entire area of the flotation tank with a resulting nonturbulent uniform flotation. This technique is not to be confused with the common practice of frothing which sweeps suspended particles upward through a flow of liquid by diffusion of air through the flow or by release of globules of gases entrained at or below atmospheric pressure.

As mentioned above, the solids in the white water are lifted to the surface by the air bubbles formed as the air comes out of solution. However, the solids usually are pretreated so that the air bubbles can take hold and lift. This pretreatment is accomplished with flocculating agents which will change the colloidal chemical properties of the white water and suspended solids. This agglomeration may require the use of a trivalent ion such as is found in ordinary papermakers' alum. However, in most cases the mill water contains enough suitable electrolyte without any such addition. A content of electrolyte is not only necessary for the flocculation but also for supplying the necessary charge to the air bubbles so that they will attach themselves and hold fast to the agglomerated particles. In addition, the flocculation of the solids produces a mat on the surface of the white water, decreases the rate of escape of air from the solution, and therefore allows the solids to become completely floated and scraped off before the air has been completely released. Final release of air takes place when the solids are discharged from an inclined table.

SAVEALL OPERATION

Under normal conditions the white water to be treated is collected in a box to which a pump is attached. A float valve may be placed on the suction side of the pump so that delivery of water is reduced if the

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quantity being supplied and the level in the box becomes low, thus preventing the pump from becoming airbound.

The discharge side of the pump is connected with the suction side by a 1/2 to 3/4-inch pipe in which an air injector is installed. The white water passing through the injector causes air to be drawn into the white water from the atmosphere. This air is mixed with the white water by the impeller of the pump. The amount of air drawn in is adjusted to approximately 1% by volume at atmospheric pressure. A 1/4-inch needle valve is mounted on the suction side of the injector so that the volume of air can be regulated. When properly regulated, minute bubbles of air will be in evidence at the inlet valve.

The pump delivers the white water and air to the inlet valve under a pressure of 40 to 60 p.s.i.

The time taken for the water to travel from the pump to the inlet valve should be at least 1 minute, this being called the retention time. If the volume contained in the piping is equal to or greater than the capacity being delivered by the pump each minute, then no special provision need be made. However, if it is less, then additional volume is necessary. This can be accomplished by: (1) increasing the length of the pipe, (2) increasing the diameter of the pipe, or (3) by adding a retention tank. Retention tanks of standard design are available in sizes corresponding to each unit. It is desirable to vent the retention tank through a 1/2-inch line to the inlet chamber. In all cases the retention tank should be installed so that the outlet is at the top.

The white water is introduced to the inlet chamber through a single or double inlet valve depending upon the size of the unit. The inlet valve is in the form of an adjustable disk which is virtually floated by the pressure of the incoming water and distributes the white water horizontally in all directions. At the same time this valve breaks up the air into minute bubbles.

The chemical solution is added at the valve discharge from a small metering unit and mixed with the aerated white water.

From the inlet chamber the white water passes over a flow distributing weir board to the main saveall tank, and the fiber and filler gradually rise to the surface. The water which flows downward in the tank becomes clarified and passes out at the bottom through a number of conical weir tubes, each having a series of graduated holes so that the effluent is drawn evenly from all parts of the tank. The top of each weir tube is adjustable so that by changing their height the level of the water in the flotation tank can be regulated as desired. The effluent falls from the weir tubes into the effluent compartment from whence it can be returned to the process, by pump or gravity, and/or spilled to the sewer.

The fiber and filler which float to the top of the tank are propelled toward the outlet end by a series of flight scrapers operating at about 5 f.p.m. These scrapers push the fiber and filler up an inclined ramp at the outlet end. The recovered stock falls from the ramp into the reclaimed stock compartment from which it is returned to the system.

Under normal conditions, the effluent will have a high degree of clarity, and except in remote cases it is ideal for use on machine showers. The clarified effluent will contain not more than 1/2 pound of filterable solids per 1000 gallons. However, under most conditions the results can be considerably better.

The recovered stock which has a consistency of 2 to 3% can be returned to different places in the stock system, preferably after the stock preparation has taken place. Some mills prefer to return it to the fan pump, others to the machine, beater, or broke chests.

When white water is treated in a Sveen Pedersen Flotation Saveall, most of the following benefits can be obtained: (1) saving of fiber, (2) saving of filler, (3) saving of chemicals, (4) saving of heat, (5) saving of water, (6) increase in paper uniformity and quality, (7) higher paper production speeds, and (8) increased wire life by reducing the amount of cold water which sprayed on a comparatively warm wire.

The normal saving which interests most mills is fiber. Filler saving is also important in many mills, particularly those using expensive fillers such as titanium dioxide.

The magnitude of the possible heat saving is often overlooked. The heat saving is accomplished through the reuse of the clarified effluent in place of the introduction of fresh cold water. The result of the reuse of the water to attain practically a closed machine system is usually reflected, particularly in winter, in higher headbox temperatures. Higher headbox temperatures often allow increased machine speeds because of better draining on the wire and easier drying. It is also possible to maintain uniform process temperatures the year round.

In mills where water is scarce or expensive, reuse can provide very appreciable economies.

Experience with over 100 operating installations in the United States has shown the primary advantages of the Sveen Pedersen saveall to be:

1. The time of circulation through the saveall is short.
2. The efficiency is high even on heavily loaded or slow stock.
3. The saveall is open, easy to clean, and all portions of the process continually open to inspection.
4. No screen to maintain or change, low maintenance costs, and no loss of time and stock due to shutdowns.
5. Fluctuations in flow and solids content may be handled.
6. Nine standard sizes of units for flows from 250 to 1500 g.p.m. allow for properly sized installations.

FLOCCULATION THEORY

In aqueous systems fibers are negative either by ionization of positive ions from surface groups or from sorption of negative ions. At high pH this charge is highest and decreases over the pH range down to pH 2 where it approaches O. If sufficient alum is added the fiber becomes positive.

Paper fibers are primarily cellulose which is a carbohydrate colloid, and in reactions where it is not decomposed, the fibers, films, and other structures show definite analogies to the properties of colloid gels. In a water dispersion the gross units are fibers and their composite fibrils.

The usual white waters contain fibers in more or less stable dispersion, the force of repulsion being determined by potential difference rather than absolute charge.

The isoelectric point of a dispersed material is that pH value of its solution at which it does not migrate in an electric field. At this point a majority of the dispersed materials' physical and chemical properties are at a minimum. The lower the charge on fibers and the smaller the hydration film the greater the floccula-

tion tendency (*1*). Opposite charges of course result in flocculation.

To flocculate such a dispersion of fiber or other papermaking materials the flocculation aids used in the Sveen Pedersen flotation process are colloidally active materials which augment dissolved air flotation efficiency by causing mutual colloidal flocculation of fiber suspension first treated with alum to enable approach to an isoelectric condition.

In this connection it is interesting to note that Thomas (*2*) found *Bacterium coli* is agglutinated by certain colloidally active materials between the isoelectric point of the colloid and the acid flocculation zone of the bacterial suspension. It is probable that attendant to fiber flocculation and flotation carbohydrate bacteria are also flocculated.

Such reduction in organism load coupled with the mutual flocculation and separation of suspended solids of fibrous dimension and also of colloidal size may account for the greater decrease in B.O.D. attainable in clarified water treated by this method. Some results obtained by Harrison (*3*) follow:

Grade	Rate, g.p.m.	5-day B.O.D. Intake, p.p.m.	5-day B.O.D. Effluent, p.p.m.
Glassine	500	267	5
Waxing	500	287	189

FLOCCULATION CHEMICALS

In the commercial operation of the saveall colloidally active flocculation aids employing glue, silica, resins, etc., have been found most efficient. The application of these flocculents is discussed.

Activated Silica Sol

This sol has been used with marked success in water treatment where flocculation is desired, and plant tests and field application indicated that it is equally applicable in the Sveen Pedersen unit.

Preparation of the sol involves the dilution of a silicate of soda of a ratio of 1:3.22, and the reaction of this dilute silicate with any of a number of chemicals which will combine with the soda and liberate a silica in sol form. For saveall work two sols have proved advantageous, the first of these is prepared by the use of ammonium sulphate as a reactant. A sol thus formed is known as N-Sol A. Sulphuric acid can be used for the neutralization of silicate in the preparation of a sol which is also effective. Such a sol is known as the Bayliss sol. These sols seem to give a floc which holds air and gives better flotation. Sodium bicarbonate as a reactant also produces a sol of similar properties. The reaction is conducted at a concentration of 1.5% silica and the sol aged at this concentration for a specified period, after which it is diluted to inhibit further aging (*4*). It is fed in this form to the white water.

As the use of the sol was expanded in different types of white water, the need became apparent that for proper coagulation and flotation there must be sufficient alumina present. In white waters from high groundwood sheets, sometimes the addition of rosin size has proved beneficial. On neutral or alkaline sheets, where it is important to avoid pH reduction much below neutrality, the addition of the alumina as alum may be prohibitive and here its use as an aluminate has been successful.

No specific predictions can be made as to the proper auxiliary chemicals or their order of addition, this depending upon the particular application. Generally speaking, there are two points in the system for effective introduction of the treatment. These are either in the sump just ahead of the pump or at the inlet of the saveall itself. Sometimes alumina is added in the sump and silica sol at the saveall, whereas in other sheets the reverse order is found preferable. Usually when size is employed it can be added to the sol itself.

As in the operation of any equipment, there are practical load limits involved. If the white water is too heavy, it is unreasonable to expect the additive to operate as economically as it would within reasonable solids limits. Relief can be gained often by increasing the retention on the wire by the addition of activated silica sol to the stock before it reaches the headbox.

Activated Sveen Glue Solution

Sveen glue solutions are prepared in water for activation at dilute concentrations, preferably 1% glue by dry weight. The most common additives to the glue are either rosin size or Mersize, the preference leaning toward Mersize, particularly the new Mersize CD-2. The percentages of either added to the glue are varied to meet individual conditions found in the white waters to be treated in the Sveen Pedersen Flotation Savealls or the stock passing over the fourdrinier wire or in cylinder molds for increased retention of fine fibers, fillers, colors, and sizing. Such percentages may range from zero to 25% dry solids basis on weight of glue; for most conditions between 5 and 10% is considered ample. Heavily filled stocks, particularly where calcium carbonate fillers are employed and where the ratio of filler to fiber in white water to be treated is high, generally call for increased percentages.

There are several formulations for activating the glue, the most common being either the use of aluminum sulphate or the procedure with chromic salts (U. S. pat. 2,403,144) which in most cases permits a lowered dosage of the Sveen glue solution at appreciable glue savings (*5*).

While it is quite true that there are some conditions where an unmodified animal glue solution will give a certain amount of flocculation or coagulation to papermaking fibers and fillers either at the consistencies they are passed on to the machine wire or into the savealls as white water, much greater activity over a wider range of pH conditions is secured when the solutions are modified and properly "aged" or ripened in accordance with prevailing formulations.

The presence of an electrolyte, preferably the alumina ion from aluminum sulphate (papermakers' alum), is quite desirable in the stock or white water system. Generally speaking, white waters from rosin-sized stocks, in pH range 4.2 to 6.8, carry sufficient residual alumina so that additional alum dosage is not required.

Some white waters at even higher pH carry sufficient alumina to react immediately with the glue without additional alum dosage. There are, of course, some white waters that have no alumina present and varying amounts of aluminum sulphate need to be introduced

first in order to secure a good vigorous rapid floc with subsequent glue dosage.

There is no over-all guide to predetermine this alum dosage and to what point the pH must be brought to secure maximum results depends upon the particular application. Excellent results have been observed on some alkaline stocks just by slightly lowering pH from around 8.2 to 7.3 with less than 1/4 pound alum per 1000 gallons white water, other cases have necessitated more extreme dosages. Experimentation under mill conditions is necessary to accurately determine correct amounts.

Glue dosages on white waters from machines making heavily loaded papers and those carrying solids above 10 to 12 pounds per 1000 gallons usually run 1 gallon of 1% glue concentration per 1000 gallons white water, which is roughly equivalent to 0.6 grain per gallon, dry glue basis. It is not unusual for such dosages to be reduced materially with lower solids per 1000 gallons, particularly with the chromic salt modification of the glue.

Studiesmade by H. R. Clodfelter (*6*) on the percentage efficiency of Sveen Pedersen savealls employing Sveen glue indicate the peak is reached at approximately 12 p.p.m. alumina as Al_2O_3 and 2 p.p.m. glue.

The proper point of introduction for alum dosage when such is required is at the collecting box or sump ahead of the white water pump, the glue solution being added as a continuous feed at the inlet to the saveall as the white water is released from pressure by the disk valve. The resulting rapid agglomeration of the flocced solids, with minute air bubbles attached thereto, accelerates their flotation in the basin and the formation of a dense fiber layer for easy removal and recovery.

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Received Feb. 8, 1949. Presented at the Annual Meeting of the Technical Association of the Pulp & Paper Industry, New York, N. Y., Feb. 21–24, 1949.

DISCUSSION

L. P. Thompson (Personal Products Corp., Milltown, N. J.): The installation of flotation-type recovery units at the Milltown plant was made mandatory because of the meager supply of raw water and the lack of sufficient filtering and treating equipment. Original plans called for the mechanical classification of white water, the flotation units being the last stage of the water clarification program. After a short operating experience, it was found that the flotation units could handle the entire job thus eliminating maintenance cost and allowing more room for other equipment. All of the sewage from the Milltown plant is piped directly to the New Brunswick sewage disposal plant. Charges are made on the basis of volume and solid contents. Because of sewage disposal charges and the desirability of recovering all possible fiber, it was necessary that the units installed function at peak efficiency almost continuously.

One 500-gallon unit is used in connection with each paper machine. The clarified effluent is used on all of the machine showers. Excess effluent is either used in the make-up or allowed to escape to the sewer. The white water for treatment is collected from the suction press savealls, felt and guard board savealls, and the wire pit. The white water to be treated runs from 16 to 18 pounds of stock per thousand gallons. Each unit recovers approximately 500 pounds of stock per hour or 6 tons per day. In addition to the recovery of fiber, approximately 720,000 gallons of water are treated and clarified every 24 hours. Although occasional cloudy periods are encountered, very nearly 100% removal of solids is obtained in normal operation.

Since the mill runs on one furnish continuously and does not use loading materials, sizing, or other chemicals, the activated silica feed is comparatively uniform, only small changes being required to compensate for operating variables. It is estimated that the chemical cost for the recovery of stock runs in the neighborhood of $2.95 per ton. The cost of clarified water is approximately $0.025 per thousand gallons. The above costs duplicate each other; that is, if the cost for clarifying water is used, it may be assumed that the cost for recovery stock is zero.

The mill has two 144-inch Yankees producing between 40 and 50 tons of tissue per day. The normal raw water demand is approximately 125 gallons per minute per machine. This includes water for pump seals, hoses, and miscellaneous auxiliary equipment. We have operated over extended periods with a minimum of 25 gallons per machine per minute raw water make-up.

Various flocculation agents have been employed and we are presently using silicate of soda activated with ammonium sulphate. We find this treatment to be exceedingly efficient and economical. Although the two units were identical at the time they were installed we find that they have certain operation variables although they are equally efficient. Experience has proved that wherever possible, it is desirable to have only one person charged with the responsibility of operation. Where various machine personnel have been allowed to make adjustments, results have been far from satisfactory.

The units are, with proper adjustment, capable of delivering recovered stock up to 1.5% consistency and the greatest problem we encountered was the handling of recovered stock. The units are located in the basement of the plant and the recovered fiber must be returned to the stock chest by pumping. The pumping of small amounts of 1.5% stock by means of a centrifugal pump was found to be troublesome. Continual air locks and pipe plugs were encountered. The situation was remedied by diluting the recovered stock to one half of 1% and then pumping it to a reserve chest where it is held for use as beater make-up water. This problem would not be encountered if it were possible to put units on the main floor where the recovered stock could flow by gravity to the stock chest.

Our maintenance costs have been nominal and we feel that all factors considered, the units have done an excellent job. We hope to install a third unit in our New Brunswick plant in the near future.

PERSONAL MENTION

Items About New and Old Tappimen

New TAPPI Members

Samuel B. Applebaum, Manager, Cold Process Dept., Cochrane Corp., Philadelphia, Pa., a 1913 graduate of Columbia University.

George J. Blake, Superintendent, Holyoke Card & Paper Co., Springfield, Mass.

Sidney J. Bragg, Librarian, Continental Oil Co., Ponca City, Okla., a 1927 graduate of Rhode Island State College.

James M. Brownell, Supervisor, Paper Testing Laboratory, Kellogg Co., Battle Creek, Mich., a 1930 graduate of Battle Creek College.

Alfred G. Bunn, Jr., Assistant to President, Berwin Paper Mfg. Corp., New York, N. Y. Attending Brooklyn Polytechnic Institute.

Charles R. Calkins, Chemist, Riegel Paper Co., Milford, N. J., a 1942 graduate of Lawrence College, with a Ph.D. degree from the Institute of Paper Chemistry in 1949.

William G. Dedert, Chemical Engineer, Swenson Evaporator Co., Harvey, Ill., a 1945 graduate of Rose Polytechnic Institute.

Clifford F. Dodge, Jr., Engineer, Sales Dept., A. J. Eckert Co., Inc., Albany, N. Y., a 1937 graduate of Tufts College.

H. Watkins Ellerson, Jr., General Superintendent, Halifax Paper Co., Inc., Roanoke Rapids, N. C., a 1939 graduate of Virginia Military Institute.

Bengt Englund, Head, Research and Quality Control, Katrinefors Aktiebolag, Mariestad, Sweden, a graduate of University of Helsingfors with a Ph.D. degree.

Edward C. Gates, Vice-President and Director, Crossett Lumber Co., Crossett, Ark., a 1921 graduate of Cornell University.

Neil C. Goodrich, Teacher, South Haven High School, South Haven, Mich., a 1938 graduate of Marquette University.

Gilbert Godin, Graduate Student, New York State College of Forestry, Syracuse, N. Y.

Silas L. Guttridge, Supervisor of Fibre Container Mfr., American Can Co., San Francisco, Calif. Attended Pennsylvania State College.

Frederick Harris-Lowe, Paper Mill Development Engineer, Ontaria Paper Co. Ltd., Thorold, Ont., Canada.

William W. Henderson, Engineering Sales and Service, W. W. Henderson & Son, Pensacola, Fla.

David W. Hengerer, Associate, R. B. MacMullin Associates, Niagara Falls, N. Y., a 1936 graduate of Harvard College.

William Herbert, Plant Superintendent, Barrett Div., Allied Chemical & Dye Corp., Peoria, Ill, a 1938 graduate of University of Cincinnati.

Robert F. Hurley, Chemist, RCA Victor Div., Radio Corp. of America, Camden, N. J., a 1935 graduate of University of Cincinnati.

Norbert Jansen, Chemist, Nicolet Paper Corp., West De Pere, Wis., a 1949 graduate of St. Norbert College.

Louis E. Kelley, Chemist, Rohm & Haas, Philadelphia, Pa., a 1938 graduate of Williams College.

Edward G. Kominek, Manager, Industrial Waste Div., Infilco, Inc., Chicago, Ill., a 1937 graduate of University of Chicago.

Thomas F. LaHaise, Jr., Paper Mill Superintendent, Imperial Paper & Color Corp., Plattsburg, N. Y. Attended Syracuse University.

Lewis Lubka, Paper Chemist, Paper & Pulp Testing Laboratories, New York, N. Y., a 1948 graduate of New York State College of Forestry.

Robert W. Lull, Technical Service, American Cyanamid Co., New York, N. Y., a 1949 graduate of Newark College of Engineering.

Stepas Malinauskas, Chemical Engineer, American Sugar Refining Co., Brooklyn, N. Y., a 1940 graduate of University of Vytautas the Great.

Thomas F. Martin, Jr., Student, New York State College of Forestry, Syracuse, N. Y.

William G. Mayberry, Engineer, Canadian Allis Chalmers Ltd., Montreal, P. Q., Canada, a 1947 graduate of University of Toronto.

Harold E. Miller, Superintendent, Technical Service, West Virginia Pulp & Paper Co., Covington, Va., a 1917 graduate of Pennsylvania State College.

Lawrence R. Miller, Metallurgist, Trent Tube Co., East Troy, Wis., a 1930 graduate of Wisconsin School of Mines.

Gordon J. Morrisette, Mill Manager, Ste Anne Paper Co., Ltd., Beaupre, P. Q., Canada, a 1922 graduate of McGill University.

Patrick C. Palmaccio, Chemist, Gibraltar Corrugated Paper Co., Inc., North Bergen, N. J., a 1948 graduate of St. John's University.

David F. Pollard, Assistant Superintendent, Bureau of Tests, Great Northern Paper Co., Millinocket, Me., a 1940 graduate of Tufts College.

Thomas E. Powers, Technical Service Engineer, Hercules Powder Co., Milwaukee, Wis.. a 1947 graduate of Virginia Military Institute.

Ralph W. B. Reade, Consulting Engineer, The Ruberoid Co., Mobile, Ala., a 1920 graduate of University of Cincinnati.

Frank W. Richardson, Manager, Northwest Filter Co., Ltd., Vancouver, B. C., Canada.

Kenneth A. Roe, Manager of Operations and Project Engineer, Burns & Roe, Inc., New York, N. Y., a 1938 graduate of Columbia University, with a B.S. degree from the Massachusetts Institute of Technology in 1941, and an M.S. degree from the University of Pennsylvania in 1946.

John E. Schermerhorn, Student, New York State College of Forestry, Syracuse, N. Y.

Guy A. Schrag, Research Technician, New York State College of Forestry, Syracuse, N. Y., a graduate of that college in 1946.

Jaggat Ram Sethi, General Manager, The Ballapur Paper & Straw Board Mills Ltd., Nagpur 1, M. P., India, a 1924 graduate of the University of Maine with an M.S. degree.

Yosizo Shimamura, President, The Kokusaku Pulp Industry Co., Ltd., Tokyo, Japan, a 1915 graduate of Kyushu Imperial University.

Nicholas Shoumatoff, Engineer, West Virginia Pulp & Paper Co., New York, N. Y., a 1939 graduate of Massachusetts Institute of Technology, with an M.E. degree from Brooklyn Polytechnic Institute in 1949.

Stanley F. Smith, Manager, Research Dept., St. Anne's Board Mill Co., Ltd., Bristol, England, a graduate of Merchant Venturers' Technical College, Bristol.

Welsey A. Sprague, Chemist, Visking Ltd., Lindsay, Ont., Canada, a 1943 graduate of the University of Western Ontario.

Walter Stern, Packaging Engineer, Kraft Foods Co., Chicago, Ill. Attended University of Illinois and Forest Products Laboratory.

Otto C. Sylwan, Mill Manager, Herre Fabrikker A/S, Herre per Porsgrunn, Norway, a 1936 graduate of Royal Technical High School.

Allan T. Walsh, Tour Supervisor, Riegel Paper Corp., Riegelsville, N. J., a 1938 graduate of University of Pennsylvania.

Baxter L. Willey, Foreman, West Virginia Pulp & Paper Co., Luke, Md., a 1942 graduate of University of Maine.

Kenneth H. Wylie, West Coast Representative, The Bauer Bros. Co., Springfield, Ohio, a 1926 graduate of Willamette University.

TAPPI Notes

Harold M. Annis has been appointed Manager of Product Development and Manager of Sales Service of the Oxford Paper Co., New York City. Mr. Annis was formerly Staff Production Manager.

Henry W. Borman is now Plant Engineer of the Southern Paperboard Corp., Port Wentworth, Ga.

Thomas S. Boerke, formerly of the Quaker Rubber Co., is now Sales and Service Engineer of the U. S. Rubber Co., Boston, Mass.

Lawrence E. Bulger is now Administrative Assistant to the Manager of Mills, Hollingsworth & Whitney Co., Waterville, Me.

C. H. Chapman, Chemist for the Hercules Powder Co., has been transferred from Portland, Ore., to San Francisco, Calif.

James H. Dutruc, Design Engineer for Papeteries J. B. Weibel, Besancon, France, has returned to France after several months training in U. S. and Canadian mills.

Arthur R. Ewing of the Bemis Bag Co., has been transferred from Peoria, Ill., to St. Louis, Mo., where he is Director of the Paper Control Laboratory.

Victor E. Fishburn is now President of the Burgess Cellulose Co., Freeport, Ill.

Matthew F. Healey, Jr., formerly partner in the firm of Healey, Foley & Olsen is now Technical Representative for Kelco Co., in New York City.

Gordon I. Hoover of the Provincial Paper Ltd., has been transferred from Thorold, Ont., to Georgetown, Ont.

Eugene G. Ingalls, formerly of the Wausau Paper Mills Corp., is now General Superintendent of the St. John Sulphite Ltd., Fairville, N. B.

Randolph N. Jacobson of the Kimberly Clark Corp., has been transferred from Kimberly, Wis., to Niagara, Wis., where he is an Industrial Engineer.

C. James Johnson, Technical Director of the Pollock Paper Corp., has moved his headquarters from Dallas, Texas, to Middletown, Ohio.

Walter A. Johnson, formerly of the Brown Co., is now Mill Manager of Pollock Paper Corp., Columbus, Ohio.

Burt L. Kassing, formerly of the Ecusta Paper Co., is now Director of Process and Product Development for the Nekoosa-Edwards Paper Co., Port Edwards, Wis.

Robert Kinne, formerly of the N. Y. State College of Forestry is now Night Superintendent of the National Paper Corp. of Pa., Ramson, Pa.

Robert B. Le Roy of the Bemis Bros. Bag Co., has been transferred from St. Louis, Mo., to E. Pepperell, Mass., as Sales Manager.

Donald J. MacLaurin, formerly of the Powell River Co., Ltd., is now Research Associate and Chief of the Pulping Section of the Institute of Paper Chemistry, Appleton, Wis.

L. G. Neubauer, formerly of Pulp and Paper Research, Institute of Canada, is now Chemist in the Dominian Laboratory, Wellington, New Zealand.

K. Umanatha Rao, formerly of the Mysore Paper Mills Ltd., is now Operative Director for the Sigpur Paper Mills, Ltd., Hyderabad, India.

Roy D. Rivers is now on the staff of the South American Division, U. S. Machinery, Inc., New York City.

Richard C. Ruffer, formerly Plant Superintendent of the American Cyanamid Co., Kalamazoo, Mich., is now Production Superintendent of American Cyanamid Co., Woobridge, N. J.

Sigura Solvason, formerly of Houston, Texas, is now Construction and Development Engineer for Merritt, Chapman & Scott Corp., New York City.

Hei Pa Wong, formerly graduate student at the University of Washington has returned to China.

* * *

The following companies have become corporate members of the Technical Association since January 1st.

Association Technique de l'Industrie Papeterie, Paris, France
Atenquique, Cia. Ind. de, Atenquique, Mexico
Ballapur Paper and Strawboard Mills, India
Columbia Box Board Mills, Chatham, N. Y.
Honshu Paper Mfg. Co., Tokyo, Japan
Jujo Paper Mfg. Co., Tokyo, Japan
Kokusaku Pulp Co., Hokkaido, Japan
Mitsubishi Paper Mills, Tokyo, Japan
Nanaimo Sulphate Pulp Co., Nanaimo, B. C.
Nippon Kako Seishi K. K., Tokyo, Japan
Tomakomai Paper Mfg. Co., Tokyo, Japan
S. D. Warren Co., Cumberland Mills, Me.

* * *

The following companies have become sustaining members of the Technical Association since January 1.

The Goldfields American Development Co., New York, N. Y.
Harris-Seybold Co., Cleveland, Ohio
The Hubinger Co., Keokuk, Iowa
New England Lime Co., Adams, Mass.
Spencer Chemical Co., Kansas City, Mo.

Industry Notes

The Mathieson Chemical Corp., has moved it headquarters from New York City to the Mathieson Bldg., 10 Light St., Baltimore 3, Md.

* * *

Thorsen Products Corp., has moved from 52 Broadway to 253 Broadway, New York 7, N. Y.

* * *

The Chromium Corp., of America has moved from 120 Broadway to 100 East 42nd St., New York 17, N. Y.

* * *

Austin College, the oldest college in Texas conferred the degree of Doctor of Humanities upon Louis Calder, President of Perkins-Goodwin Co., New York, N. Y., for his contribution to the development of Southland Paper Mills at Lufkin, Texas, and the whole South industrially.

* * *

C. B. Harris, formerly Manager of the Textiles Section, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., has been made Manager of the Contracts-Miscellaneous Section, Dyestuffs Sales Division, Organic Chemicals Dept. He was succeeded by G. M. Markle, former Manager of the Lakes, Paper and Leather Section. K. C. Johnson, former Asst. Manager of the Dyestuffs Division, took Mr. Markle's place.

* * *

Erwin Schmidt and Eberhard H. Goebel, Directors of Zellstofffabrik Waldhof have returned to Germany after having investigated semichemical operations in American mills.

* * *

Arthur A. Hauck, President of the University of Maine has announced that a five-year course in pulp and paper technology will be given by that institution starting next

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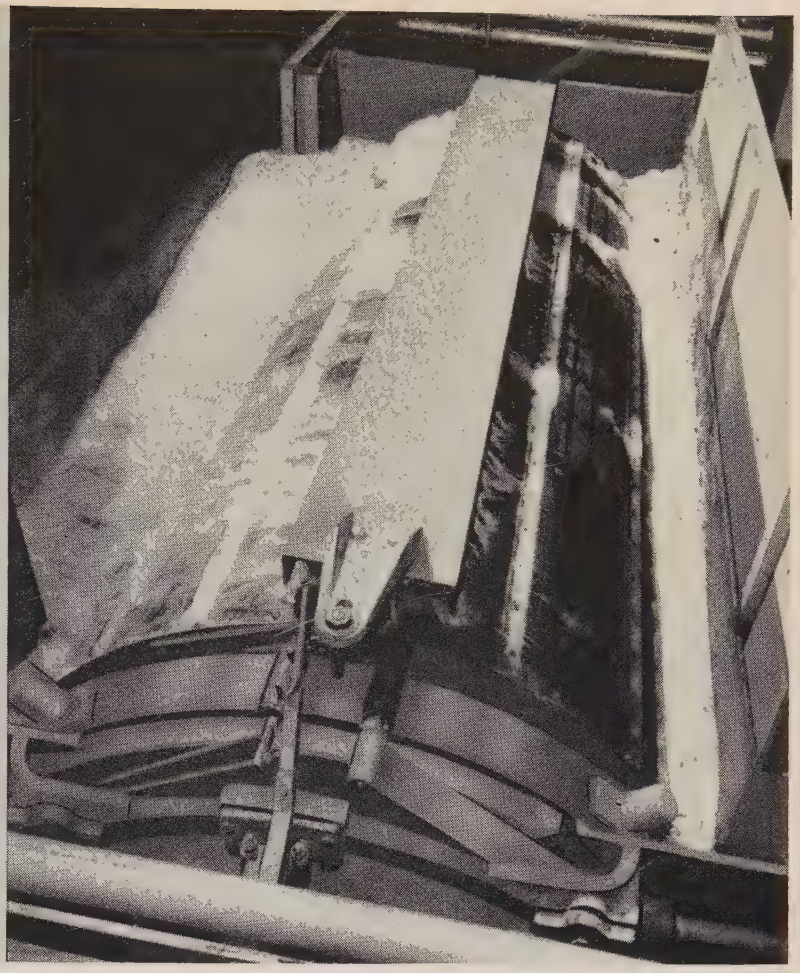
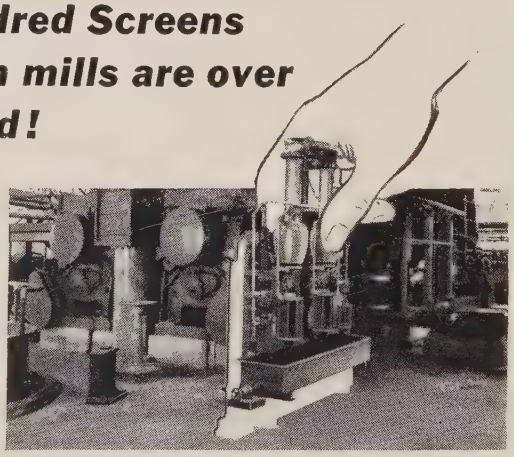


— but more than seven hundred Screens now in operation in American mills are over twenty years old!

Mills with big, new Bird Screens have a tremendous production advantage.

Take a look at *your* Screens, now. If there's any doubt as to their ability to meet present standards of capacity, dirt removal efficiency and screening economy get in touch with us at once.



HAVE YOU DONE THIS FOR YOUR SCREENS?

Dirtec tailings units cost little — make a whale of a difference in operating efficiency and economy. Mill after mill is replacing obsolete tailings handling equipment with the Dirtec. May we give you the facts and figures?

BIRD MACHINE COMPANY

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fall. This does not replace the present four or five year courses but differs in that the first three years will be devoted to the chemical engineering course and is open only to students who show an aptitude for management. Details may be obtained from Professor Lyle C. Jenness, Head of the Department of Chemical Engineering.

* * *

The Ingersoll-Rand Co., 11 Broadway, New York 4, N. Y., has announced a new type of diesel engine, in the 195–375 hp. range. Since diesel engines in this range have been either automotive type units at top limits of speed and rating, or derated heavy, slow-speed engines the TS diesel is said to fill a long felt need in industry for an engine in the 900–1000 r.p.m. range.

* * *

Samuel M. Langston Co., of Camden, N. J., has announced the removal of its Chicago office from 720 N. Michigan Ave., to 919 N. Michigan Ave. (Michigan 2-2962). Walter J. Goettsch, Vice-President and A. G. Oberland, Sales Representative will be located at this address.

* * *

The Philadelphia Quartz Co., Public Ledger Bldg., Philadelphia 6, Pa., manufacturers of soluble silicates has prepared a chart for the preparation of activated silica sol coagulent aids from 41° and 42° Baumé silicates. The chart is helpful to industries using coagulation processes for the treatment of raw water, industrial wastes, and reclamation of white water in paper mills. Suitable for posting, the chart correlates flow rate and SiO_2 dosages to determine sodium silicate requirements, quantity of reacting chemical, dilution volumes, expected alkalinity of some preparations and feed rate of silica sol for flow variations. Copies will be sent on request.

The Philadelphia Quartz Co., has announced the opening of its new research laboratory at Primos, Pa., near Philadelphia. This laboratory will be devoted to search for fundamental knowledge about soluble silicates and to the development of new and improved products. The old laboratory at 121 South 3rd Street has been vacated.

* * *

The Polytechnic Institute of Brooklyn, 99 Livingston St., Brooklyn 2, N. Y., is conducting the following laboratory courses in June and July. Each course is open to individuals qualified to take them: June 26–30 Advanced X-ray Diffraction; June 26–30 Methods in Physical Biochemistry; July 17–21 Weight and Shape of Polymers in Solution; and July 31–August 4 Techniques of Polymerization and Copolymerization. Details may be obtained from Professor H. Mark.

The new research laboratory of the Philadelphia Quartz Co. at Primos, Pa.

* * *

The New York and New England district offices of the Manhattan Rubber Division, Raybestos-Manhattan Inc., have been moved from 120 Broadway to 500 Fifth Ave., New York City.

* * *

De Laval Steam Turbine Co., has issued two new bulletins: Bulletin 1125 Type CP Process Pumps and H-HS IMO-De Laval Herringbone Gear Reducers.

* * *

Homad Services Ltd., 1445 Crescent St., Montreal 25, P. Q., has been appointed as engineering sales representative in Canada for the Stacomizer by Stacom Industries, 29–28 41st Ave., Long Island City. N. Y. The Stacomizer is a machine used to press bark and other materials to remove

12 BASIC CHEMICALS

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MATHIESON

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water. A press is in commercial service in the mill of the Anglo-Canadian Pulp and Paper Mills Ltd., Quebec, P. Q. Frank S. MacDonald is Vice-President of Homad Services, Ltd.

* * *

The Philadelphia Quartz Co., Public Ledger Bldg., Philadelphia, 6, Pa., has issued a bulletin (15-1) on Coating Paper with Sodium Silicate. Silicate coated paperboard is used for food containing fats and oils.

* * *

Charles A. Walmsley and Edwin P. Stevens have been elected to the Board of the Cameron Machine Co., 61 Poplar St., Brooklyn 2, N. Y. Mr. Walmsley was formerly works manager for the International Derrick and Equipment Co., Marietta, Ohio, and Mr. Stevens is a partner of the law firm of Winthrop, Stimpson, Putnam and Roberts.

* * *

At the National Packaging Exposition in Chicago, Lake Michigan water was wrapped in souvenir pouches made of paper coated with "Alathon" polythene resins and distributed by E. I. du Pont de Nemours & Co., Inc. Papers coated with various "Alathon"-wax blends for food packaging were shown.

* * *

Robert W. Lea, President of Johns-Manville Corp., has been elected a member of the Board of Directors of Olin Industries, Inc.

* * *

Ford Ballantyne, Jr., has been elected Vice-President of the Wyandotte Chemicals Corp., and Bert Creamers has been elected Vice-President of the Michigan Alkali Sales Division.

* * *

The National Adhesives Division, National Starch Products, Inc., 270 Madison Ave., New York 16, N. Y., has issued a very informative booklet on "Successful Can Labeling." An interesting feature of this publication is a chart showing the causes and correctives of labeling difficulties. These include staining of paper labels, rusting, slipping, poor adhesion at overlap, curling, wrinkling, etc. It is a trouble shooting booklet.

* * *

H. G. Ebdon and William P. E. Ainsworth have been elected Vice-Presidents of Combustion Engineering-Superheater, Inc., New York, N. Y. Mr. Ebdon is General Sales Manager of boilers and related equipment. Mr. Ainsworth is in charge of purchasing and production of the company's six American manufacturing plants.

* * *

The American Paper and Pulp Association estimated the capacity of the industry at the end of 1949 as 12,191,550 tons of paper and 11,762,580 tons of paperboard. The capacity planned for the end of 1950 is 12,477,060 tons of paper and 11,909,675 tons of paperboard, and for the end of 1951 it is 12,526,660 tons of paper and 11,917,425 tons of paperboard.

* * *

The Grinnell Company, 260 Exchange St., Providence 1, R. I., has issued an 88-page catalog (wf-1950) on seamless carbon steel welded fittings and forged-steel flanges.

* * *

The American Cyanamid Co., has announced the formation of the Dyes and Chemicals Export Department to handle foreign activities of the Calco Division, Industrial Chemicals Division, and Plastics and Resins Division. The combined department is under the direction of Fraser M. Moffat, Jr.

The Bagley & Sewall Co., Watertown, N. Y., has opened an office in New York City at 500 Fifth Avenue. The office is in charge of Joseph S. Scheuermann, Vice-President of the Converting Equipment Division for the sales of mill and converting type winders, laminating and other special converting equipment for paper, textiles, and rubber.

* * *

The Industrial Chemicals Division of the American Cyanamid Co., has announced the appointment of Robert W. Lull as West Coast sales-service engineer for the Company's Paper Chemicals Department. He will work with Ed Garrison, Paul Ochs, and Herb Pratt, sales representatives respectively in Seattle, San Francisco, and Los Angeles. He will be located in Portland, Ore. Mr. Lull was with the Hamersley Mfg. Co., Garfield, N. J., prior to joining the Stamford Research Laboratories of Cyanamid.

* * *

Wire cloth production has been resumed at the Cleveland, Ohio plant of the Lindsay Wire Weaving Co., following a 50-day work stoppage. Full scale production of fourdrinier and cylinder machine wires is now in process and customer orders are being filled as rapidly as possible.

* * *

The Armstrong Forest Co. of Johnsonburg, Pa., has issued a folder which describes a method of poisoning standing timber so as to facilitate bark removal. Tests by Armstrong foresters indicate that trees treated with sodium arsenite during the sap season may be cut and peeled at almost any time during the year. Heretofore peeling has been confined to the sap season, May to July.

OBITUARY

Harry W. Schwartz

Harry W. Schwartz, 51, Vice-President of the Robertson Paper Box Co., Inc., Montville, Conn., died recently at his home after a prolonged illness.

Mr. Schwartz was born March 26, 1899 in Boston, Mass., son of Maxmillian and Ann Schwartz. He was educated in the public schools of Boston and Cambridge and was graduated from Harvard in 1922 and attended the Harvard Graduate School of Business Administration in 1922 and 1923.

Since June 26, 1923, he has been associated with the Robertson Paper Box Company, Inc. After working in the plant he became Box Factory Superintendent in 1925, Purchasing Agent in 1930, Assistant Treasurer in 1932, a Director in 1934, and a Vice-President in 1940.

Mr. Schwartz held the position of president of the Connecticut Association of Purchasing Agents in 1942 and was a director of the National Association of Purchasing Agents in 1943. He served on several committees of the Folding Paper Box Association of America and on the Paperboard Industry Survey Committee. He was a member of TAPPI, and the Occupational Health Council of the Manufacturers Association of Connecticut, Inc.

He is survived by his wife Mary K. Schwartz, a daughter, Miss Marlene Schwartz, a student at the Masters School, Dobbs Ferry, N. Y., and a son, Norman H. Schwartz, a student at Governor Dummer Academy, South Byfield, Mass., also, a sister, Mrs. John W. Thornton of Winchester, Mass.

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Pulp Stones by CARBORUNDUM are available in various structures to meet your specific grinding conditions. Produced under scientific control, they offer safe continuous low cost operation.

These wheels operate on long burring cycles assuring fewer variations in pulp quality. They are strong, durable, and economical. The Carborundum Company, Niagara Falls, New York.

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TAPPI DIVISIONS AND COMMITTEES

Reports of Activities

Digester Corrosion Subcommittee

The first meeting of the Digester Corrosion Subcommittee of the Chemical Engineering Committee was held at the Statler Hotel in St. Louis, Mo., on March 30–31, 1950. All of the members of the committee were present.

The personnel of the Digester Corrosion Subcommittee is as follows:

J. R. Lientz, *Chairman*, Union Bag & Paper Corp., Savannah, Ga.
H. O. Teeple, *Secretary*, International Nickel Co., New York, N. Y.
T. T. Collins, Thilmany Pulp & Paper Co., Kaukauna, Wis.
O. T. Defieux, Crown Zellerbach Corp., Camas, Wash.
W. J. Shelton, Longview Fibre Co., Longview, Wash.
Nicholas Shoumatoff, West Virginia Pulp & Paper Co., New York, N. Y.
Wayne Smith, Crossett Paper Mills, Crossett, Ark.

The committee plans to prepare a questionnaire to be sent to all kraft and soda pulp mills in the United States to determine the nature of the digester corrosion problems and the action which the individual mills have taken.

It is proposed also to make a thorough study of the literature concerning all phases of digester corrosion.

Since the digester corrosion problem exists in other countries the committee hopes to establish a liaison with the Canadian and the Scandinavian Associations.

Electrical Engineering Committee

The Electrical Engineering Committee is now preparing for its sessions at the Fifth Engineering Conference of the Pulp and Paper Industry to be held at Cincinnati on Oct. 2–5, 1950.

Its present personnel is as follows:

A. S. Goodrich, *Chairman*, Hammermill Paper Co., Erie, Pa.
G. W. Knapp, *Secretary*, General Electric Co., Schenectady, N. Y.
R. R. Baker, Westinghouse Electric Corp., E. Pittsburgh, Pa.
E. L. Cowan, Gaylord Container Corp., Bogalusa, La.
F. L. Davis, West Virginia Pulp & Paper Co., Luke, Md.
R. W. Davis, Allis-Chalmers Mfg. Co., Norwood, Ohio
T. Foulkes, E. B. Eddy Co., Hull, P. Q.
Ray Foster, Champion Paper & Fibre Co., Canton, N. C.
A. O. Mortenson, St. Regis Paper Co., Pensacola, Fla.
J. L. Van Nort, Reliance Electric & Engineering Co., Cleveland, Ohio
R. F. Sorenson, Union Bag & Paper Corp., Savannah, Ga.

For the current year the committee is continuing its study of the "Power Requirements for Paper Machines." The various sections of the machine are being studied, a few at a time, beginning with the fourdrinier by two-men teams. These teams consist of a paper industry man to direct the investigation and obtain data, and a representative of an electrical manufacturer to supply instrumentation as required, to help with the analysis, etc. In the case of fourdriniers, one such team has already turned in its results, another is about ready to begin work, and two more are being activated. Each team is working from a suitable test procedure which has been set up by Mr. Goodrich and the Electrical Engineering Committee and will give to him the analysis of their results for study, correlation, and report to the membership of TAPPI.

The next subject on the committees priority list is the study of motor characteristics, enclosures, and insulations, and bearings. A subcommittee has been appointed to start the job and to report on one or more of the phases of the broad subject. R. F. Sorenson of the Union Bag & Paper Corp. has been appointed Chairman and will be assisted by Ray Foster of the Champion Paper & Fibre Co., and Mr. Knight of the Gaylord Container Corp. It is expected that the subcommittee will decide on what division of the problem will be made among its members, appointing special subcommittees, where necessary to include motor manufacturers' representatives and others, as required. This is an important activity and it is expected that a good part of the over-all problem will be reported at the Engineering Conference in Cincinnati.

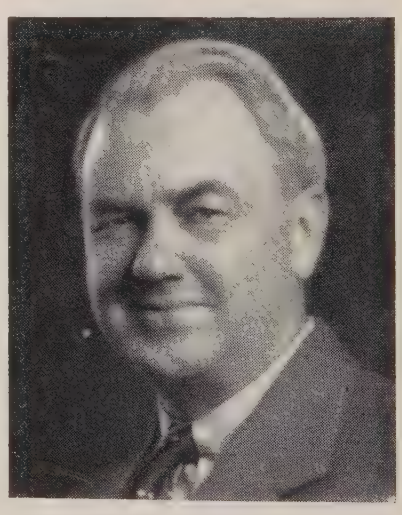
It is expected that cable will be investigated following the Conference and reported at the 1951 Conference. Mr. Mortenson is making a preliminary study of this subject to establish a proper method for making the investigation.

Tom Foulkes of the E. B. Eddy Co., is a member of the C.P.P.A. Engineering Committee and is now serving on the TAPPI Electrical Engineering Committee to provide liaison between the two committees.

G. W. KNAPP, *Secretary*

Bibliography Committee

The Technical Association of the Pulp and Paper Industry is probably unique in that it has, among its standing committees, a Committee on Bibliography. The report of the Publication Committee by Charles F. Rhodes [*Paper* 17, No. 24: 142, 144 (Feb. 23, 1916)] discussed the question of pulp and paper abstracts (how they were to be obtained and possible support for their publication) and stated: "It is also planned to prepare a bibliography of the publications on pulp and paper." In the early days there were two committees



C. J. West, Chairman, of the TAPPI Bibliography Committee

Soya Products Division of Glidden, Chicago—America's vast center of soybean research and processing often referred to as Soybean City.

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of TAPPI—the Committee on Bibliography with Henry E. Surface as chairman and the Committee on Abstracting Technical Literature, of which John D. Rue was apparently the first chairman [*Paper* 20, No. 12: 32 (May 30, 1917)]. In addition, there was a committee on abstracts of the Technical Section of the Canadian Pulp and Paper Association. The last two committees cooperated in the preparation of abstracts, which were published in *Paper* and in the *Pulp and Paper Magazine of Canada*. The first abstracts in *Paper* appeared in the June 26, 1918 issue; the *Pulp and Paper Magazine* carried abstracts from January, 1918, the earlier abstracts being the work of the Canadian committee.

V. E. Nunez was chairman for one year and was followed by Ross Campbell who served until the two committees were combined in 1923 under the chairmanship of Clarence J. West.

Abstracts were published in *Paper* through 1921. In 1922, TAPPI initiated the *Technical Section* as a part of the *Paper Trade Journal* and the abstracts were published rather consistently until early in 1940. As a result of the space required by the growing volume of abstracts and also because of the increase in the number of papers which had to appear in the *Technical Section*, it became impossible to continue their publication in that form. In view of the recognized importance of the abstracting service, the Executive Committee decided to issue the abstracts as a separate publication. The result was *Papermaking Abstracts*, of which volume one (in two parts) appeared in 1941–1942. The activities of the chairman of the committee during the war years prevented further work of this nature and, therefore, TAPPI's activities in this field came to a close in 1942.

As mentioned earlier, the Committee on Bibliography was started under the chairmanship of Henry E. Surface, who continued until his untimely death in a railroad accident in the summer of 1920. Mr. Surface was particularly well qualified for this work, because he was prominently connected with the work on papermaking conducted by the Bureau of Plant Industry and the Forest Service; furthermore, he had done considerable bibliographic work for the U. S. Government. Following his death, Clarence J. West was appointed Chairman of the Committee. In 1923, the Committee on Abstracts and the Committee on Bibliography were combined and became the Committee on Abstracts and Bibliography. In 1948, when it became apparent that the abstracting function of the committee had been abandoned, the name was changed again to the Committee on Bibliography.

The original idea of Mr. Surface involved the compilation of bibliographies on special subjects with the thought that "when a sufficient number of special bibliographies have been developed and when funds are available, it will be possible to compile a general bibliography in the best and most convenient form for the use of the members of the Association." [*Paper* 20, No. 12: 33 (May 30, 1917)]. The first phase of Surface's idea was followed for several years and resulted in some forty-five bibliographies [for a list of these, see *Technical Association Papers* 11: 78–79(1928)].

The first annual bibliography of pulp and paper literature was compiled by West in 1920 and was published in *Paper* 20, No. 7. Succeeding bibliographies (some with A. Papineau-Couture) were published in the Convention Issues of the *Paper Trade Journal* through 1930. In 1926 the scope of the work was extended to include U. S. patents (these were published only in the *Technical Association Papers*). Because of the increasing size of the annual compilations, it became necessary, in 1931, to issue the bibliography as a separate publication, which included both the periodical literature and the patents; such volumes were issued for 1931–1934, 1936–1944, and 1946–1948. The missing years were included in the composite volumes.

In 1928, it seemed that the time had come to realize Mr. Surface's ambition to issue a "general bibliography." The first volume covered the period from 1900 to about June, 1928. This volume included the annual bibliographies for 1920 to 1927 and, in addition, it contained material which had been accumulated by a page-by-page search of the various papermaking periodicals. This search was made possible by the excellent facilities of the libraries in Washington, D. C. (especially that of the Department of Agriculture). The second collective volume was issued in 1935 (1928–1935) and the third in 1945 (1936–1945). The fourth volume is in process and will cover the years 1946–1950. The present compilations are possible because of the cooperation of The Institute of Paper Chemistry.

The Chairman is pleased to express his appreciation to J. F. Ohlson, A. Papineau-Couture, and C. E. Peterson who were responsible for most of the abstracts.

Clarence J. West, *Chairman.*
Institute of Paper Chemistry, Appleton, Wis.

Papermaking (Cylinder) Committee

The Papermaking (Cylinder) Committee is planning to issue two questionnaires during the year in preparation for its next annual meeting.

The first questionnaire is to be based on the evaluation of stock cleaning efficiencies. W. H. Caddoo of the Robert Gair Co., Uncasville, Conn., is in charge of the preparation of this questionnaire.

The second questionnaire will deal with variations in weight and caliper across the machine. Glen T. Renegar of the Container Corp. of America, Manayunk, Pa., was appointed to work out a suitable questionnaire on this subject.

The 1951 annual meeting of the committee will be devoted to a consideration of wet-end operations, problems, and developments of the cylinder machine. The following are members of the Committee:

J. J. Harrison, *Chairman*, Michigan Carton Co., Battle Creek, Mich.
P. S. Bolton, Robert Gair Co., Uncasville, Conn.
H. E. Brakewood, National Folding Box Co., New Haven, Conn.
W. H. Caddoo, Robert Gair Co., Uncasville, Conn.
A. T. Luey, Sutherland Paper Co., Kalamazoo, Mich.
A. L. Sherwood, Sutherland Paper Co., Kalamazoo, Mich. (Advisory Member)
B. M. Thomas, Ohio Boxboard Co., Rittman, Ohio
W. R. Tobin, American Box Board Co., Grand Rapids,
P. J. Trucano, Morris Paper Mills, Morris, Ill.
G. T. Renegar, Container Corp. of America, Manayunk, Pa.

James J. Harrison, *Chairman*

Papermaking (Fourdrinier) Committee

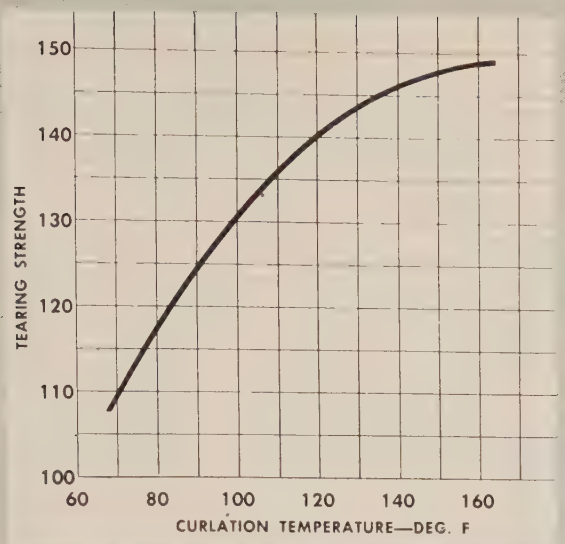
The annual meeting of the Papermaking (Fourdrinier) Committee was attended by T. M. Barry, Hollingsworth & Whitney Co., Harry S. Spencer, Howard Smith Paper Mills, Vernon P. Tipka, News Print Service Bureau, F. O. Boylon, Crown Zellerbach Corp., L. P. Thompson, Personal Products Corp., Hugh Morton, S. D. Warren Co., Fritz Klein, Byron Weston Co., R. Hitchings, New York State College of Forestry, S. A. Staege, Black-Clawson Co., Robert Pattison, Cellulose Fibres, Inc., and Noel R. Phillips, Champion Paper & Fibre Co., Chairman.

The members agreed to a panel meeting for the 1951 meeting to be held in New York. Tentatively, the following subjects will be given consideration:

1. Screens vs. no screens on the machine.
2. Approach flow and slices for high-speed kraft operations.
3. The importance of shake.
4. Flat boxes.
5. Dandy-type table rolls vs. plain table rolls.
6. Forming boards vs. aprons.
7. Deckle straps vs. rulers.
8. Effect of wire length.
9. Air entrainment.

It was felt by the committee that the basic fundamentals of fourdrinier operating technique can be presented in data

TEAR CURVE



Effect of Temperature During Curlation Using Power Consumption of 2.5 H. P. Days Per A. D. Ton on the Properties of

PREVIOUSLY UNDRIED NORTHERN UNBLEACHED SULPHITE PULP

TEST DATA

TEMPERATURE OF CURLATION °F	RAW*	70	120	160
FREENESS	835	835	845	856
MULLEN	70.8	62.1	52.6	37.8
TEAR	95	109	140	149
DENSOMETER	14.0	3.7	1.2	0.7

*WITHOUT CURLATION

NOTE: Description of the testing procedures employed by The Curlator Corporation laboratory will be provided upon request.

The CURLATOR† is a tool for altering the properties of pulp and paper to obtain qualities hitherto unachievable by mechanical means. The effects of CURLATION are controllable over a wide range by conditions of treatment. They vary with the raw material and may be described only in relation to a particular pulp.

MAY CURLATION SOLVE YOUR PROBLEM?

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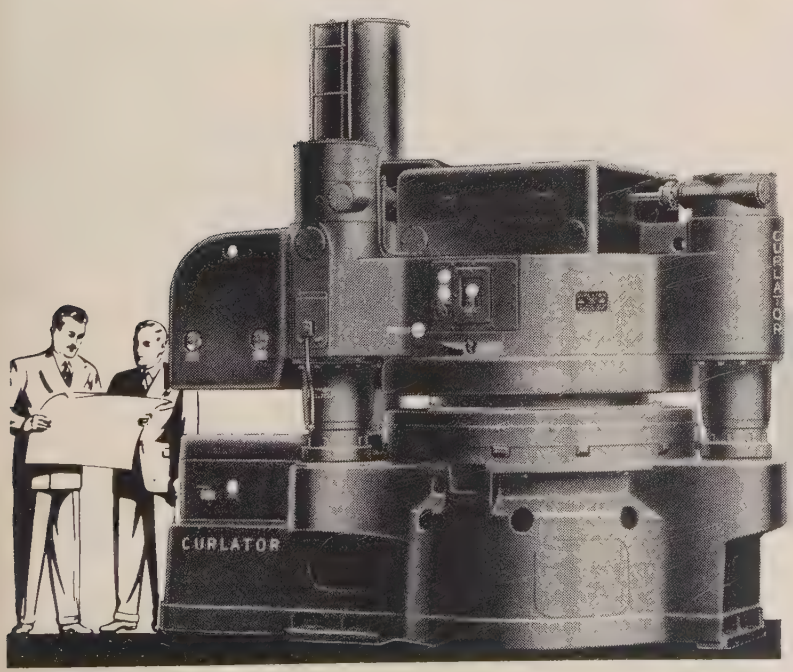
The effects obtainable with CURLATION vary widely with the raw material and the conditions of treatment. In general, CURLATION tends to produce an easier beating pulp from which water is more easily removed.

Sheets of CURLATED pulp exhibit a more even textured matte appearance.
In addition, the range of qualities obtainable from a given pulp is broadened.

Other important advantages exist.
Your inquiries are invited.



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sheet form. An attempt along these lines will be made with the papers presented at the 1950 meeting.

A questionnaire on the importance of the shake will be prepared and circulated among the committee members prior to a mailing to the mills in the United States and Canada. This questionnaire and the responses will be used as a basis for part of the 1951 meeting.

During the meeting held in February an interesting discussion on galvanizing and shadow marking took place. The excellent results suggested that in the future the Committee may hold an invitation meeting to discuss certain paper defects on a cause and remedy basis. Guests of the Committee will be invited but it will not be an open meeting.

A vote of thanks was given to Messrs. Boylon, Tipka, Pattison, and Staege for their fine papers given at the annual meeting and another vote of thanks to Messrs. Barry, Spencer, Thompson, and Zellers for their remarks in participating in the meeting.

The personnel of the Papermaking (Fourdrinier) Committee is as follows:

Noel R. Phillips, *Chairman*, Champion Paper & Fibre Co., Canton, N. C.
T. M. Barry, Hollingsworth & Whitney Co., Waterville, Me.
N. I. Bearse, Champion-International Co., Lawrence, Mass.
W. J. Cassidy, Sorg Paper Co., Middletown, Ohio
R. W. Pattison, Cellulose Fibres, Inc., Holyoke, Mass.
H. S. Spencer, Howard Smith Paper Mills, Beauharnois, P. Q.
L. P. Thompson, Personal Products Co., Milltown, N. J.
V. L. Tipka, News Print Service Bureau, New York, N. Y.
C. T. Welte, Champion Paper & Fibre Co., Canton, N. C.

Résumé of Session on Papermaking Slices

The following is a brief résumé of the general discussion on paper machine slices during the annual meeting:

1. When high-consistency stock is used it is important to have localized fiber movement without excessive turbulence. This, of course, relates back to the design of the box itself which should be made so that a baffle box will not give dead spots which tend to gather lumps and strings.

2. Fin-type table rolls were not mentioned but have been used with considerable success to help formation and to eliminate galvanizing.

3. The design of suction-box covers can have a considerable influence on the retention of a quality sheet. It is obvious that they have no effect on the main formation.

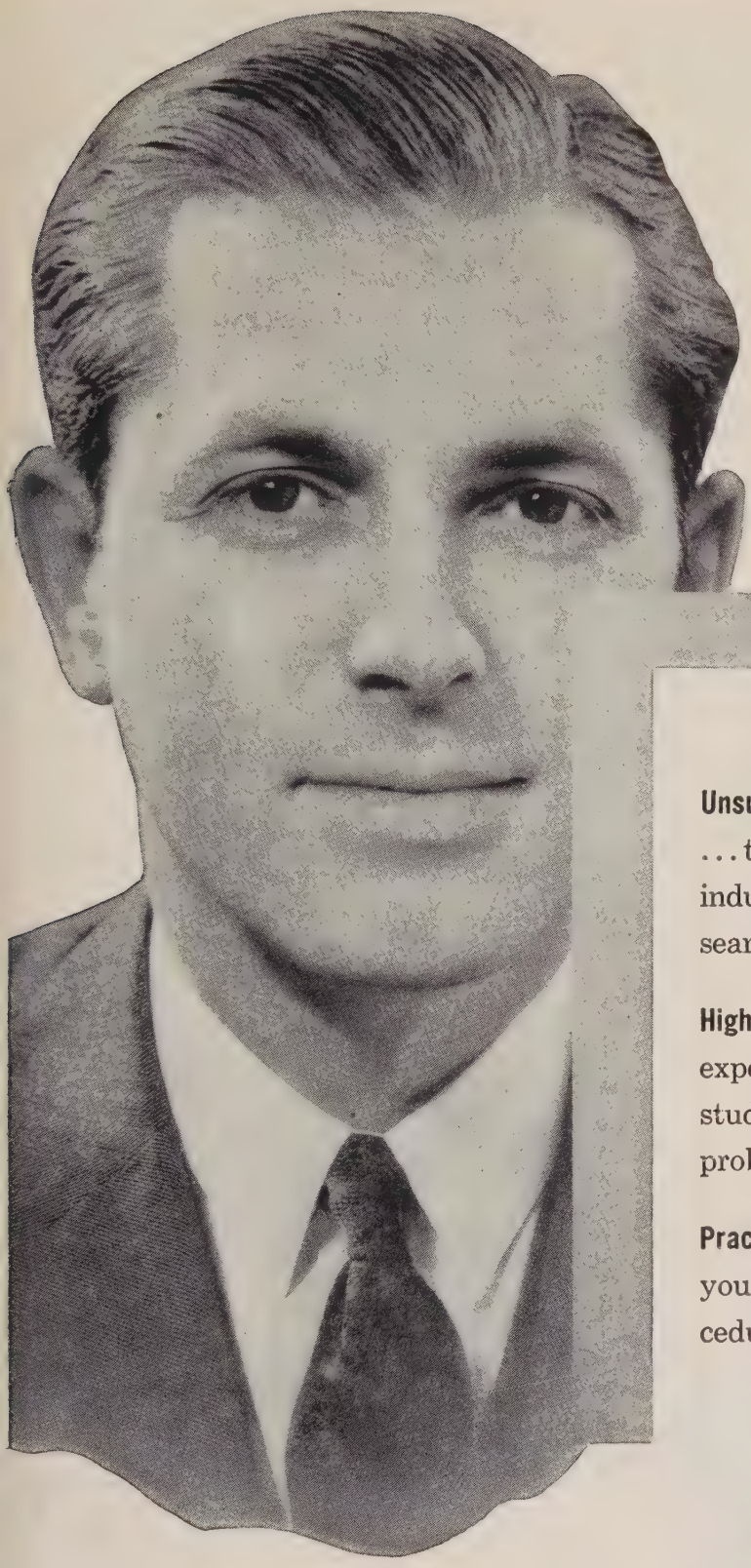
4. One of the commentators brought out the point that none of the panel authors mentioned the importance of a slice opening as regards accuracy and no one mentioned the importance of supporting a wire directly beyond the breast roll, by either a forming board, deflectors, or even a small table roll. These factors contribute to the effect of the flow through the slice orifice.

5. A written comment was expressly directed at the pitch of a fourdrinier and the effect of pitching the bottom lip of the apron or slice. It was brought out that the apron-board on a pitched slice must be pitched. (I believe that this is a half-statement as the pitch of the apron board is dependent on whether the slice is moved beyond the end of the apron or behind the apron. In other words, by moving the slice forward, the orifice is directed down on to the wire.)

NOEL R. PHILLIPS, *Chairman*

Corrections in TAPPI Standards

In the recent mailing of loose-leaf TAPPI Standards there were two errors in printing. The code number of the method for Abrasion Loss of Paper and Paperboard, printed as T 476 8m-49, should be T 476 m-49. In T 227 m-49, Freeness of Pulp, the brass screen plate is described in the third paragraph under Apparatus as being 0.20 inch thick. This should read: The brass screen plate is 0.02 inch thick and has perforations of 0.02 inch diameter, etc.



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Unsurpassed starch chemistry research ... the foremost research men in the industry direct a continuing basic research program in starch chemistry.

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LOCAL SECTION ACTIVITIES

Reports of Meetings, Personnel and Events

Lake Erie

Over sixty persons were on hand for the April 21 meeting of the Lake Erie Papermaker's and Converter's Association. As usual, the dinner and meeting were held at the Hickory Grill in Cleveland, Ohio. Loren B. Sjöström of Arthur D. Little, Inc. presented a paper on "Odors in Relation to Paper Products and Packaging."

Art Cheely of Hankins Container Co. reported that the nominating committee has decided to nominate the present officers for re-election because of the youth of the association and the excellent work that the present officers have done in getting the group started. Lew Burnett of Ohio Boxboard was nominated Chairman, Bill Manor of Consolidated Paper Co., 1st Vice-Chairman, Peter Spring of Chase Bag, 2nd Vice-Chairman, and Bill Schoenberg of Lord and Schoenberg, Secretary-Treasurer. Bob Leaf of Ohio Boxboard was nominated for the newly established office of Recording and Corresponding Secretary. All of the nominees are members of TAPPI.

Nominations for the Executive Committee were as follows: James Kudrna of Jaite Co., David Cooper of Buckeye Ribbon and Carbon Co., Bill Hasselo of Container Corp. of America, J. W. Noll of Munroe Falls Paper Co., Bill Barger of Great Lakes Box Co., Dave Shotwell of International Printing Ink Co., Art Cheely of Hankins Container Co., and P. H. McDowell of A. L. Garber Co. In addition to Art Cheely, Art Kjellstrand of Buckeye Ribbon and Carbon Co., and P. H. McDowell of A. L. Garber Co. served on the nominating committee.

Kon Matchuk, chairman of the Miami Valley Division of the American Pulp and Paper Mill Superintendents Association, was given a special greeting to the meeting. Kon countered with an invitation to all members of LEPCA to attend any of the meetings of his group.

On May 19 Joe Steinbrunner discussed "Printing Inks." His talk was planned so that it was of special interest to both papermakers and converters. Joe is Assistant Factory Manager of the International Printing Ink plant in Chicago.

Odors and Packaging Papers

Loren B. Sjöström who is in charge of the Flavors and Odors Group at Arthur D. Little, Inc. presented the following paper on "Odors in Relation to Paper Products and Packaging":

Loren B. Sjöström addressing Lake Erie meeting. Bill Manor at left.

"The consumer has a right to expect a product to be unaffected by the container in which it is packed. For purposes of limiting scope, this talk will discuss paper products designated primarily for food usage and will deal with odors occurring in paper products, omitting problems peculiar to individual foods or of contamination from outside sources such as may occur in warehouses and retail stores. It has become a part of the American way of life to use paper containers more and more for packaging of foods, practically all of which, whether to be cooked or eaten directly, are susceptible to contamination by odor of packaging materials. It stands to reason that the paper industry must be doing a good job in view of the considerable tonnage of the paper-packaged food products currently consumed. Since the paper industry is frequently faced with odor problems in an effort to maintain top quality in their products, it is intended in this paper to cover some of the more important aspects of odor and its relation to paper products.

Nature of Odor

"Odor is that property of a substance which excites the sense of smell. Very minute quantities of materials in air suffice to produce an odor; and for some substances, such as mercaptans, as little as 3.3×10^{-5} parts per million produces a recognizable odor. It is generally accepted that odor is caused by molecules of chemical elements and chemical compounds dispersed in the air. Thus, for a paper product to give odor, there must occur a chemical substance, generally solid in nature, which volatilizes into the gaseous phase and is picked up by the nose receptors for recognition. In contamination of a food product a condensation of the odorous gas occurs on or in the food which is later observed by the consumer.

Odors Occurring in Paper Products

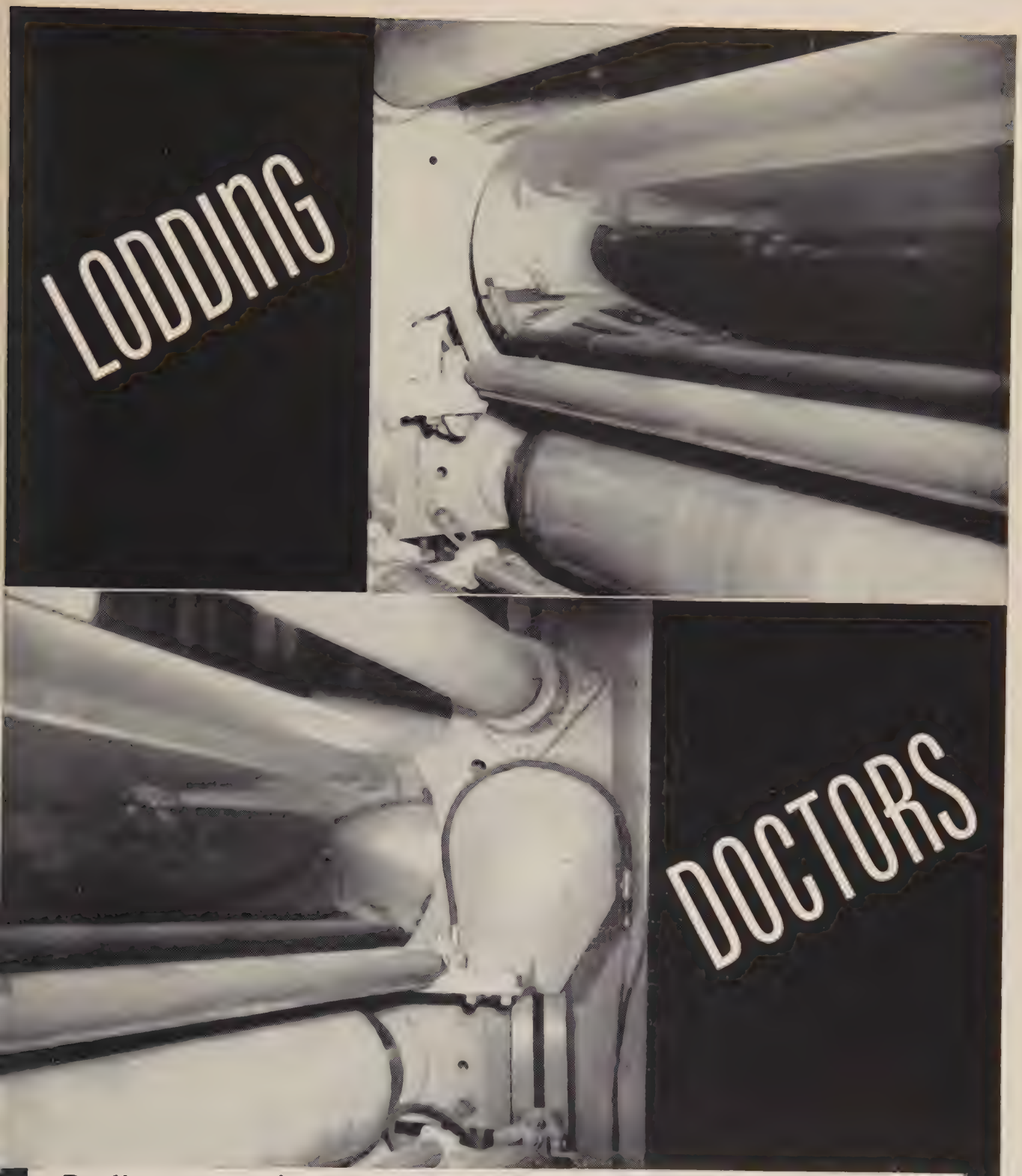
"Odors found in paper products may be grouped into three very general classifications: (1) natural pulp odors, (2) odors produced in manufacturing, and (3) added odors. In papers made from virgin pulps low levels of odor usually occur, and these odors are typical of the source and treatment. For example, no odor is detectable in alpha cellulose, whereas kraft has a typical sweet coumarin mercaptan-like odor. These odors are seldom considered objectionable, chiefly because they are low in intensity and are unnoticed in the natural flavor of foods.

"Frequently, during the manufacture of paper a musty or moldy odor is produced. This is often traced to the development of slime or use of poor water in the system. Slime may also impart sour and putrid odors to paper, depending on the nature of the causitive organisms. In attempts to hold the development of slime to a minimum, the paper manufacturer has widely utilized chemical fungicides. These can give rise to the occurrence of another type of off-odor, and the misuse of these substances has perhaps caused a greater number of complaints against food containers than any other source. The typical "chemical" or "medicinal" odor which may result from their misuse, and which transfers to foods readily, is entirely foreign to foods and appears to register to the consumer only as severe contamination. Coatings, sizings, fillers, and strengthening agents occasionally produce odors in papers. However, these substances are usually selected with low odor and seldom are causes of complaints. A typical instance is the use of sodium silicate coating on paper which produces an eggy amine odor that appears to have no nuisance value. Some antifoams and dispersing agents also have odors that persist through the papermaking process.

"Added odors refer to all the remaining odors which occur in paper and are usually contributed by the furnish, printing, or adhesive. As may be imagined, this category includes odors of all varieties from many sources, especially where waste, cuttings, and clippings are part of the stock. An attempt has been made in the following table to list the more common of these off-odors which have been observed in studies of paper made at the laboratories of Arthur D. Little, Inc.

Control Methods for Judging Odors

"There are several tests for odor in paperboard that are employed routinely in the Flavor Laboratory of Arthur D. Little,



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Inc. The tests run on the paper alone are more critical and quicker than paper tests carried out by shelf-life studies of packaged food products.

"These first tests are conducted on every sample of paper or paperboard that is received. They are simple tests that can be used by anyone. In fact, it is advocated that their rudiments be taught to the workers in paper plants who can readily do preliminary screening of manufactured stock.

Left to right: Art Cheely, Bob Leaf, Bill Manor, Bill Schoenberg, Lew Burnett, and Dave Cooper

"All are based on the fact that odor is volatile to some degree. The paper as-received is sniffed. If odor is strongly perceptible, it is rejected. With a moderate to light odor the paper is questionable and must be checked further. Even though no odor is perceived, the sample is lightly wetted in various areas and the vapor checked for odor. For this purpose, we use a letter moistener filled with water. A variation of this technique, if no moistener is at hand, is to exhale on the sample, sniffing for odor immediately. The principle behind this technique of moistening the board is that of steam distillation. The water on the lightly wetted surfaces slowly evaporates and takes with it the odoriferous molecules.

"A method devised to check earlier findings is called a water soaking test. In this test, the paper is cut in narrow strips about three inches long. About ten of these are placed in a four-ounce wide-mouth glass bottle which has previously been rendered odor-free. The bottle is half-filled with distilled water. It is then topped with a watch glass and allowed to stand for a limited time, preferably 24 hours. The bottle is then cautiously sniffed. This test will always confirm previous rejection of samples and will sometimes point out other odor-emitting samples. It is especially suited to the comparison of a large number of samples.

Typical Off-Odors Found in Paper Products and Their Sources

Classification	*Source*
Industrial chemicals	Chlorine, hypochlorite, phenol, ozone
Oils	Fuel oil, gasoline, kerosene, rancid fat, soap, carbon paper, inks, varnishes
Mustiness	Algae, musty stock, musty water, partially degraded sizing
Perfumes	Perfumed stock, sweeping compound, coating perfumes
Nonperfume aromatics (mercaptans) (amines) (sourness)	Garbage, residues in used stock, adhesives

"Paperboard designated for food packages is given more stringent scrutiny. There are three extremely sensitive odor transfer tests which are carried out at room temperature. The first one is designed to ascertain the nature of the odor. A covered glass dish large enough to hold two petri dishes is used; in a chemical laboratory a desiccator might be appropriate, however, a common household refrigerator dish is satisfactory. One of the petri dishes holds a small quantity of distilled water; the other, odorless mineral oil. Strips of board are set in the large dish, not in contact with the liquid media, and the dish is covered. After 12 to 24 hours, the petri dishes are removed, and the water and oil are sniffed for odor. Usually both oil and water soluble odorants are found in suspect paperboard. Such odors as gasoline, and those from printing inks and varnishes, are picked up by the oil. The odors of mustiness and sourness would be absorbed by the water.

"In a second test, a 'sandwich' is prepared of two pieces of board and a pat of high-score, fresh butter. Butter has been found to be an excellent test medium since it contains, among others, fat, water, and milk solids. In both odor and flavor good butter is very well-blended. When off-odors are imparted to butter, a change especially noted in flavor is effected. The bland character is lost, and the balance of the various aromatic notes perceptible in the flavor is upset.

"At least two 'sandwiches' are prepared and placed in a covered glass container, as it is customary to check both sides of the board. At the same time, a dish containing butter but no board is set up as a control. After 24 to 48 hours at room temperature, the butter is examined by tasting and compared with the controls.

"It is also possible to set up a test where the board is not in contact with the butter. Such a test is often employed to check the odor of an outside carton in which food materials, individually packaged, are shipped.

"Another medium, like butter but even more susceptible to upset in flavor balance, is plain milk chocolate. In the chocolate test, board samples are placed in a closed container but out of contact with the chocolate. The covered glass containers with the board and chocolate are held for one to two days, after which time minute bites of the test and control chocolates are tasted. This very critical test was devised by the Manayunk Laboratories of the Container Corporation of America.

Elimination of Odors

"The preceding parts of this talk have all been leading up to one theme: Paper need not have objectionable odors. If it does, they have been added sometime between pulping and final use, and adequate precautions have not been taken to prevent them.

"Care must be taken in the choice of used stock which should be free of all strong odors or substances that may be sources of odors. Bales should then be stored where they do not become wet and moldy. It has been found practical and also good psychology to train plant workers to check all stock on arrival at the plant or before being fed to the beaters or hydrapulpers.

"The liberal use of chlorine is not only useful in the control of organisms, but it has deodorancy value. Other fungistats must be properly used. Of course, it is very important that systems be shut down frequently and given adequate cleaning.

"An increase in water temperature in the whole system where possible will volatilize low boiling odor compounds and therefore remove them.

"In containers where printing inks are prominent, oil inks should be selected which dry to a low-odor level. In extreme cases where no ink odor can be tolerated, vapor set or steam set inks are recommended.

"Finally, in every plant, an individual, properly selected and preferably from the laboratory staff, should be placed in charge of all odor work. He should select a panel to work with him frequently and help to pass on critical decisions. Through experience the individual will be able to establish tolerance levels on paper and paperboard for each type of product.

"It is impractical and uneconomical to run the risk of odor hazards when, by taking such precautions as have been outlined, a paper manufacturer can produce a wholly acceptable product."

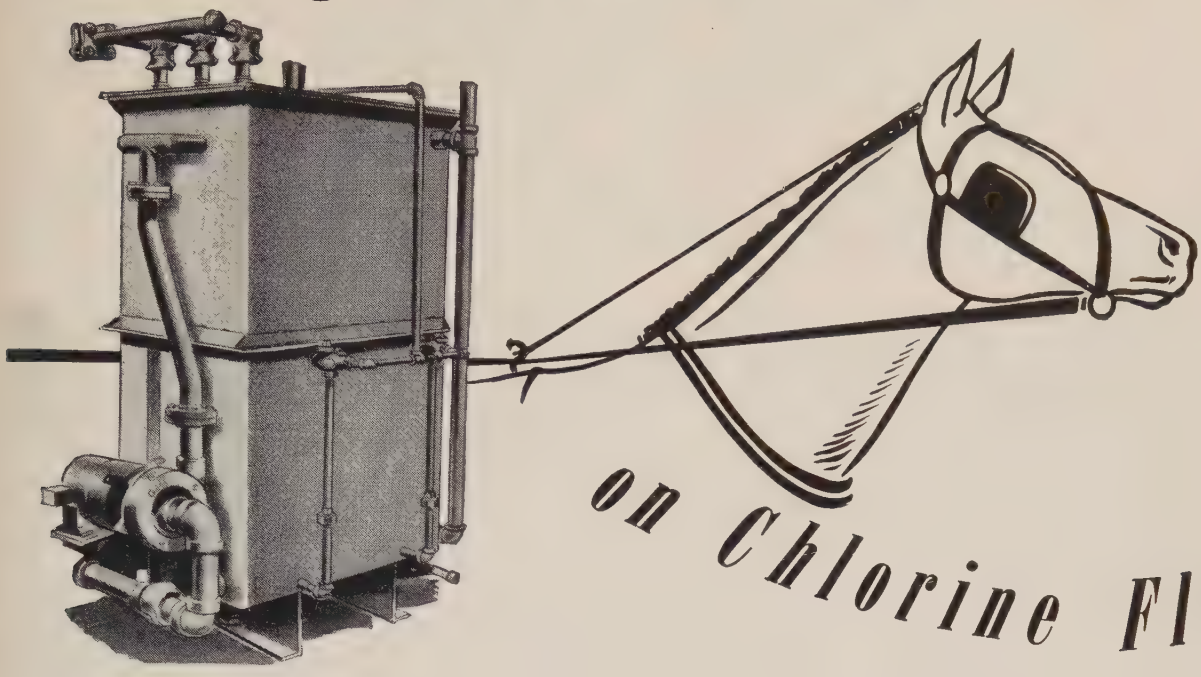
R. L. Leaf, *Recorder*

Chicago

In the May issue of *Tappi* the program of the April 17 meeting of the Chicago Section was outlined. Among the speakers was J. Watson, Manager of the Technical Service Department, J. M. Huber Corp., New York, N. Y. Mr. Watson discussed "Printing Inks." His remarks follow:

"Letterpress printing is the oldest printing process and by far the most important in terms of volume of the three major printing processes today. There is a great diversity in the kinds of work produced by letterpress printing. It is so diffuse that no one exactly knows its extent. It ranges all the way from the tiny shop with an old hand-fed platen job press, to the giants whose press floors cover acres. From these pressrooms, great and small, come an endless stream of books, magazines, journals, corrugated containers, paper and cloth bags, folding boxes, food and candy wraps, newspapers, oil and water color painting reproductions, theatre tickets, bus transfers, mail order catalogs, and a

Putting a Checkrein



on Chlorine Flow

Even as short a time ago as 1930 the methods of controlling and measuring chlorine were quite unsatisfactory. A batch of liquid chlorine was put in weigh tanks. This measured weight was then evaporated and conveyed to the point of use. To use this batch of prepared chlorine gas in a continuous bleaching process required a close control that was just unobtainable with existing equipment.

Variations in temperature and pressure caused erratic gas flow from the evaporator. With a demand of up to 2000 lbs. per hour, reducing valves of that date were inadequate. How to maintain uniform pressure and temperature therefore was a problem tackled by Hooker chemists and engineers.

This problem, in so far as it relates to temperature, was solved by the design of a chlorine evaporator that maintained a constant chlorine gas temperature. This evaporator was patterned after a boiler with the chlorine entering at the bottom through tubes which rose through a hot water bath. Water temperature was regulated by the injection of steam, whose flow was controlled by a solenoid valve and mercoid switch. The switch was actuated by the temperature of the chlorine gas leaving the evaporator.

A baffle plate freed the rising chlorine gas from drops of liquid and dry chlorine gas at uniformly held temperature was collected in a dome or chamber at the top of tubes. From this point the chlorine gas was fed through the necessary control equipment to its place of use.

By means of such improvements in the handling of chlorine, Hooker has continued its close association with the pulp and paper industry. Our purpose has been to make it easier and safer for you to use chlorine. Today, as in the past, the problems you are daily encountering are of concern to us. One basic way in which operating problems are kept at a minimum is in supplying you with uniform high quality chlorine, caustic soda and other chemicals.

When assistance is needed in handling Hooker Chemicals, call upon our Technical Service Department.

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host of other printed matter designed to educate, entertain, protect, and advertise.

"Letterpress printing inks are classified in many ways. The inkmaker usually classifies them first of all by the type of product to be produced in the graphic arts field, for example, publication inks, kraft bag inks, corrugated container inks, etc. A second classification is usually made within the above product groups and deals with the major printing ink functions. Here the inks are classified into: (1) Absorption Inks, (2) Oxidizing Inks, (3) Evaporation Inks, (4) Filtration Inks, and (5) Precipitation Inks. The next classification would be the type of printing press to be used for the particular operation and finally the inks may be further classified as to the particular paper surface for a specific job. Because of time limitation in this talk, I have necessarily condensed and simplified the classifications. However, they do represent the most important points. Since the group here tonight is representative of the paper industry and printing industry, without being specifically attached to any one kind of paper or any one kind of printing, it is best that I talk of letterpress inks on the basis of the printing ink functions.

Absorption Inks

"These inks are probably best typified by the inks generally used in newspaper printing. Newsprint is highly absorbent and acts like a blotter. The inks are therefore formulated to permit fast blotting action. Newpapers usually are not in continuous production. In most cases they operate in 15 to 30 minute cycles, six or eight times during a six-hour production period, and are standing idle the rest of the day. Therefore, inks which do not dry on the press are preferred to avoid expensive wash-up. Absorption inks are basically formulated with nondrying mineral oils, with varying quantities of rosins or resins plus necessary pigments for color. Many of the comic supplements and most of the comic books are printed with absorption inks although a few are now being printed by other functional ink groups to a limited extent.

"These inks also lend themselves to the printing of books, pamphlets, etc. on soft bulk papers. Such absorbent papers generally require inks of this nature, although certain printing requirements call for inks which are a combination of absorption and oxidizing types.

"Inks in this group are made in viscosities suitable for almost every type of relief printing from the very heavy body required on a job press in tropical climates, to the very fluid viscosities required by large metropolitan dailies. A considerable amount of work has been done in ink laboratories, press rooms, and other places in trying to determine if some of the other functional types of inks could be used to gain their advantages without presenting undue disadvantages. In most cases the cost of redesigning equipment, the higher cost of inks, plus some other problems of lesser importance, have ruled against the general adoption of other ink types to newspaper printing in spite of their obvious advantages.

Oxidizing Inks

"Inks in this group are essentially based on vegetable drying oils and rely generally on the printed film absorbing oxygen to promote hardness and drying. Such inks usually set into the paper or board surfaces quite slowly and require many hours to become completely dry. Many modifications of these inks are made, including those containing resins, waxes, and greases to promote different properties in the inks, to facilitate their use on various paper surfaces, and sometimes to further harden the surface for resistance to marring. In many present-day formulation they are often modified with absorption inks, evaporation inks, or filtration inks.

"These inks can be made in a variety of finishes from very dull surfaces to those of extremely high gloss. They can also be made with varying degrees of resistance to alkali, soap, acid, light, fats, oils, greases, alcohol, etc. They are also made in a variety of viscosities and tack to suit the particular kind of press and paper. They are used in the production of almost every type of letterpress printing.

"In the publication field they are extensively used in books, magazines, catalogs, journals, house organs, etc. In commercial fields they are used in the production of brochures, letterheads, handbills, and the variety of other work generally done in the small job shop and larger printing establishment. In the packaging field they are widely used on multiwall bags, corrugated containers, folding boxes, food wrappers, etc.

"This group of inks has its origin at least as far back as Gutenberg's time and continued in almost exclusive use until the introduction of other functional ink types and new printing processes. In later years these inks have been improved and refined tremendously by modifications as outlined before. However, much of the volume printing formerly done with this type of ink has been replaced by the evaporation and precipitation types of inks, particularly in long-run roll-fed printing.

Evaporation Inks

"These inks are widely known under such trade names as Heetset, Vaporin, Flash-Dri, etc. This type of ink first came into use in the publication field some fifteen years ago and it's suitability lies in the replacement of drying oils with solvents. They are essentially compounded of pigments, binders, and solvents, with the solvents being of such a nature that they are relatively stable on the press at room temperature but can be burned off or evaporated at elevated temperatures. They require the use of drying equipment, coupled and synchronized with the press.

"Their most important use at present is in the publication field where they permit very high speeds with instant drying, enabling the printed web to be immediately folded and cut into signatures and often even bound in one continuous operation without smearing, offset, or sticking. Entirely new presses have been designed and are now in operation to take advantage of this heatset principle and these presses are coupled with a variety of drying equipment. These driers are essentially chambers or tunnels enclosing flame units, steam drums, hot air, infrared units or combinations of these. The paper web is usually passed through a drying unit after one side is printed, then continues into the second printing unit for other-side printing, and on through a second drying unit.

"It is a fair statement to say that many of our modern news magazines, such as Life, Time, News Week, Business Week, Quick, etc., owe at least a part of their success to the discovery and development of heatset inks and heatset printing which permit the speedy printing and distribution of news in picture and story, while they are still of immediate interest.

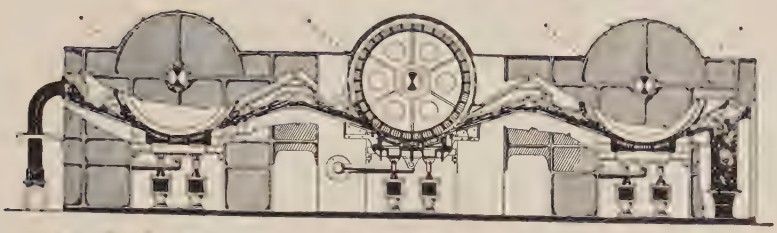
"By far the biggest volume of magazine work is done in black and white but the development of four-color process inks in heatset formulation has enabled a considerable amount of colored advertising to be transferred from the slower oxidizing-ink-printing to the modern high-speed heatset press. Much of this four-color heatset printing is now being done with inks of high finish and even gloss.

"The introduction of machine-coated papers to this field, has been of material help to the magazine industry in providing a relatively low cost-coated paper in rolls and in tremendous quantities to keep pace with the needs of the magazine industry. A major problem to the inkmaker has been that of trying to formulate suitable inks for the widely varied machine-coated surfaces being produced. Some of the paper in recent years has been so nonuniform, highly calendered, and polished, and with very hard and very soft spots that it becomes almost impossible to formulate inks that will give the necessary press performance and still lay smoothly and sharply on the paper. There are many excellent coated papers on the market which provide good affinity for inks and permit the printer to stock only a limited number of inks to meet his needs. The less desirable papers usually require an increase in the number of inks to be stocked by the printer and some of the sheets are so unprintable that even with the combined efforts of printer and inkmaker it is still impossible to achieve good printing quality.

"The degradation of paper by excessive heat is a problem concerning the industry and is becoming of greater importance as we go to heavier forms and multicolor. Heat degradation of paper in the publication field causes a number of difficulties, not the least of which are web breaks, folding cracks, lost press time, spoiled paper, overruns, etc. Millions of dollars per year are lost by heat degradation alone. Ink formulation materials are available which could prevent most, if not all, of this tremendous loss, but the printing and publishing industries in most cases strongly resist price increases and the inkmaker is usually compelled to make ink to a price rather than to a job, in order to survive. It has been amply demonstrated on many occasions that more expensive-per-lb. inks will effect lower printing costs, better jobs, fewer problems and less trouble. In the meantime, considerable work is being done to develop inks in this group and other functional groups to minimize such problems in the publication field, at such unreasonably low prices as are demanded.

"This type of ink is used quite extensively in the packaging field, since a rather considerable part of the packaging field is of a nature that would permit the application of the heatset process. Soon after the introduction of heatset inks to the publication field, packaging printers, who printed from roll to roll, investigated the heatset method and many of them have followed initial experimentation into regular production in their fields. The introduction of heatset inks to this field permitted instant drying with elimination of offset and smudging. If further permitted the immediate use of printed rolls on the bag-forming or wrapping machinery and in so doing effected a considerable decrease in floor space required for the storage of printed rolls while drying. Continued improvement of ink formulation now enables the production of bags printed with high gloss inks having extreme rub-resistance, at speeds very close to those of the newspaper and magazine fields and on a variety of paper surfaces. The modern coffee bag best typifies this type of printing.

NOBLE & WOOD



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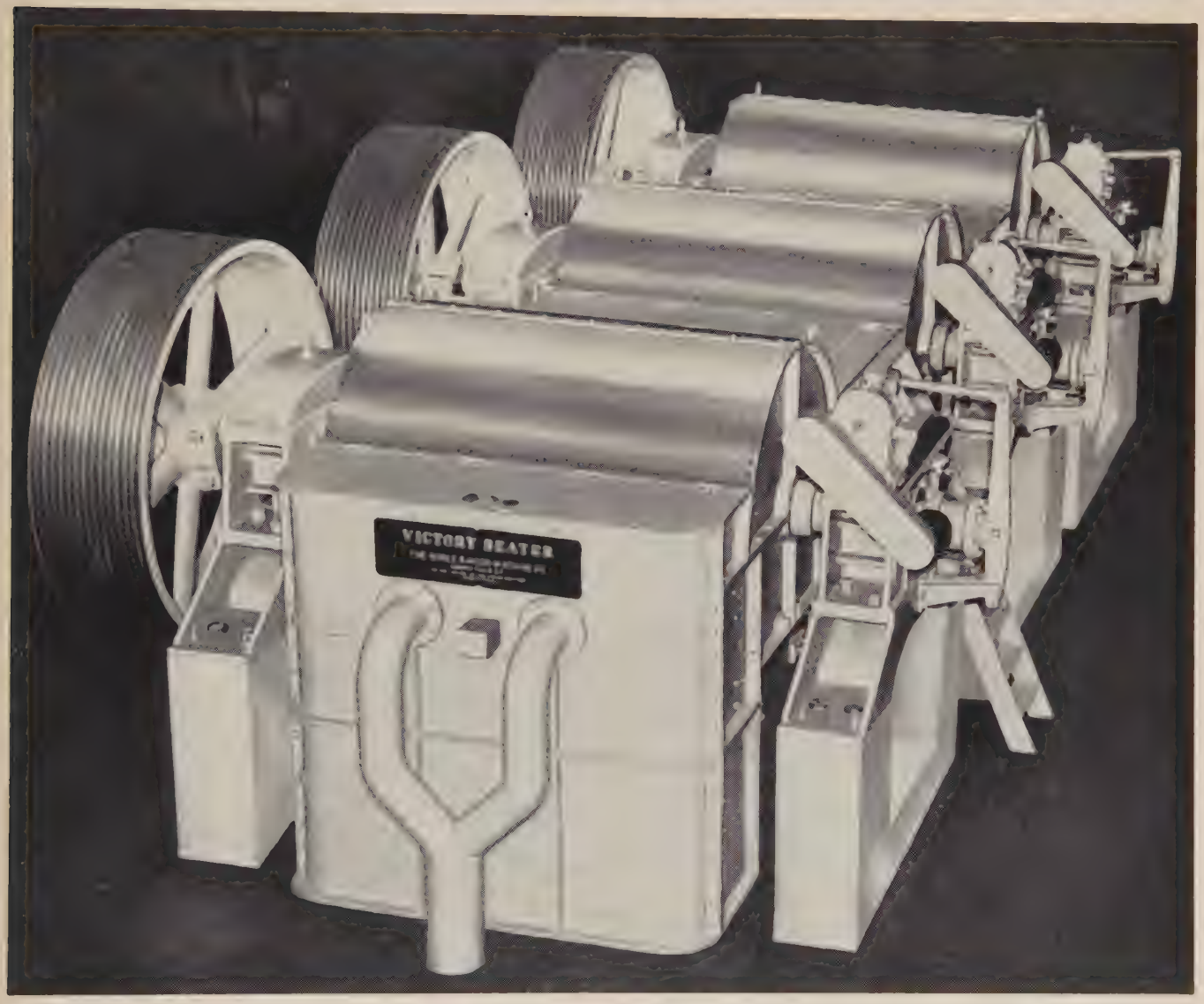

The first practical method of applying intensive beater roll treatment to large tonnages of wood pulps on a continuous production basis.

On hard kraft pulp for bag and wrapping papers at the rate of 150 tons per day, 175 tests indicate the following: Power saving 35%, Freeness drop (Canadian) 190 cc, Mullen increase 25%, Tensile increase 20%, Tear-no change.

Attention pulp manufacturers: produce premium pulps by pre-treating your standard grades with the Multi-Roll Victory Beater.

For further information regarding Victory Beaters, write for Bulletin Tap 650.

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Pulp and Paper Mill Machinery

HOOSICK FALLS, N. Y., • U. S. A.

"Most other printing operations generally done in medium or small printing houses, do not lend themselves too well to heatset printing for several reasons, the chief of which are the cost of heating apparatus and short runs. However, in recent years modifications of full heatset inks have been made and they now find fairly widespread advantages on flat-bed cylinder presses in publication of small magazines, house organs, brochures, and folders. In these cases the heatset inks are really semiheatset and are a combination of heatset and conventional oxidizing formulas. The usual gas bar on the end of such presses permits a slight solvent evaporation and allows the ink to set quite rapidly, thus permitting fairly quick handling of the printed sheets. Infrared drying units are gaining popularity for this type of work.

"Evaporation inks can be provided for newspaper printing, in fact, they are being used in some cases. They will give the advantages of the magazine field, namely, elimination of offset and smudging and provide completely dry newspapers. Heatset printing permits sharper printing in newspapers, eliminates strike-through, and reduces show-through. A major difficulty preventing their adoption generally in the printing of newspapers is the very limited amount of space available for drying equipment. Then too, heatset inks for newspaper printing would cost several times as much as conventional news inks and even though ink represents only a minute fraction of newspaper production cost, the industry is not reconciled to increased price for ink and extra investment in redesigning of equipment and acquisition of heating apparatus. With heatset inks it would be necessary to spray the distribution system of each unit just prior to starting to replace solvent evaporation on the press rollers. There are a number of successful applications of heatset inks in the printing of newsprint but for the most part they are confined to the printing of magazine supplements, catalogs, handbills and shopping news. Most of the equipment used in these cases is of a newspaper type or modified magazine printing equipment.

Filtration Inks

"This type of ink is comparatively new. It was first introduced just prior to the last war but not until after the war were materials or time available to properly develop the ink. The original formulas were essentially based on rubber resins in colloidal solution, or dispersion in solvents, so prepared that immediately after the printing impression solvent rapidly drained into the paper coating, giving an almost instantly set and rapidly hardening film.

"These inks have been quite successful in the small and medium size pressrooms when used on slow job and cylinder presses on coated papers. They set within seconds on good brush coated stock and within a few minutes on many other papers. They are very suitable for quick work-and-turn jobs. An additional advantage to the small printer is the fact that these inks normally do not skin overnight. They have not been too successfully used on faster presses because of their marked tendency to fly and string from fast moving press rollers.

"There have been many modifications of this type of formula and some of the newer inks are more suitable for higher speeds. Usually these modifications do not set quite as fast. Some of the newer formulations tend to skin overnight, but their speed of setting and drying is still fast enough for quick work-and-turn jobs. The most successful of the modifications seem to be partly of the filtration type and partly evaporating type. They are very much similar to the modified heatset inks for cylinder press use previously mentioned. Colored inks have been made on the filtration principle and find some limited applications.

Precipitation Inks

"These inks are well known under the trade names Moisture-set, Hydry, Vaposet, etc. They are composed generally of higher alcohols, resins, and pigments. The resins selected are soluble in the glycols only in the presence of a limited amount of water, and when the printed film is exposed to the application of steam or water vapor the resin is precipitated from the glycol, forming a hard resin-pigment film. On most stocks they will set and harden in 15–30 minutes without extraneous moisture, and on some stocks they are dry enough immediately after printing to rewind without moisture application and without offset.

"Precipitation inks have a number of desirable properties when printed. They have no residual odor, can be waxed within one or two hours, permit good heat sealing, are quite brilliant, have little or no offset, have excellent rub resistance, are noncrystallizing, print sharply, and often give better mileage than inks of the oxidizing type. Many of these properties indicate the applicability of this type of ink to food packaging and they have met with outstanding success in the packaging field.

"This type of ink is assuming major importance in the multiwall kraft bag industry and permits printing and rewinding of continuous paper web at speeds up to 1000 feet per minute without offset. The high-moisture content of kraft aids in setting these inks rapidly and only with heavy multicolor over-lapping forms is steam or other moisture externally applied. These inks at present do not have much finish or gloss except on a few special surfaces. Ink laboratories, however, are working on the problem of producing gloss and may ultimately find the way. Their outstanding brightness and rub resistance quite effectively take the place of gloss finish in producing desirable appearance.

"Moisture set inks are used extensively on bread wrappers and many other food packages. More recently they are beginning to attain popularity in the printing of corrugated containers. They print sharply on containers and cover smoothly on solid type and reverse type. The colors have life and brilliance. The inks set within 15 minutes and are usually rub proof one hour after printing, permitting quick movement to the tapers and stitchers.

"Moisture-set inks have possibilities in other fields. Considerable experimental work has been done in newspaper printing and while they have many advantages, they have one or two disadvantages, not the least of which is their considerably higher cost than conventional news inks. They are ideally suited for most letterpress printing operations calling for long run web printing, and in many cases can be used without the need for press modification or extraneous apparatus. It is likely that this type of ink will enter into more and more of the letterpress printing field in the future.

"In conclusion I would like to emphasize one or two points, particularly in the field of publication printing, and directed chiefly to the paper manufacturer.

"Machine-coated papers for publications are most widely used in the 43–50-lb. basic weights. Those papers that give best printability have quite uniform formation, have smooth coating, comparatively free of pinholes, without too much luster, are not hard calendered. The coatings seem to be chiefly clay, with some calcium carbonate, and are applied in quite abundant film thickness.

"Those papers which we find most difficult to print, and which give mottled uneven solids, poor dot structure, and generally 'mealy' appearance, usually seem to have very wild formation of the body stock, very thin layers of coating, little more than a wash size in some cases and often with chunks of wood visible to the naked eye.

"There seems to be no good reason why publishers or printers should buy a poor quality of paper, unless price is predominant. Most paper buyers go by color, surface appearance, tear strength, and price, but are unable to tell about printability until the paper is on the press, and yet we see papers that have poor color, poor surface appearance, and low tear strength. Most good pressmen and ink formulators can spot poor-printing papers at a glance, most of the time.

"There are several excellent machine-coated papers on the market, and many others that are good. It is unreasonable to expect the printer to produce quality printing on a paper surface lacking printability, therefore, I believe it is necessary that there be closer cooperation between the paper, printing, and ink industries to be sure we have common understanding and objectives. Don't you feel that we need to talk over and think about our relationship to each other as often as possible? And don't you think that we surely and rapidly can dissipate any feeling of 'buck passing' if we mutually review our problems and mutually agree on remedies?"

Adhesives Meeting—May 15

A panel forum on adhesives featured the meeting of the Chicago Section at the Chicago Bar Association on May 15.

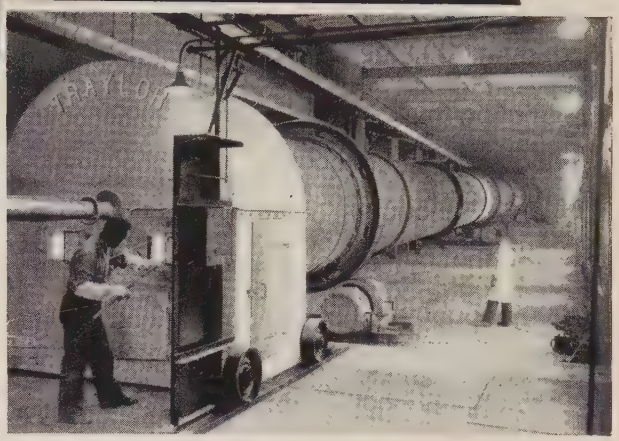
Speakers included Roger Shoals, Manager of the Adhesives Dept., Stein-Hall & Co.; Samuel Shuller, Technical Director, Paisley Products, Inc.; R. L. Pett, Resin Technical Service, National Starch Products, Inc.; and William Gray, Technical Director of the Arabol Mfg. Co.

Ohio

One hundred and ten members and guests registered for the dinner meeting of the Ohio Section held April 13, in the Manchester Hotel in Middletown, Ohio. The dinner was called at 6:45 p.m. after which a brief business meeting was held, presided over by the Chairman, Arthur Thurn of the Champion Paper and Fibre Co.

A very interesting program was arranged by M. S. Lyon of the Champion Paper and Fibre Co., the subject under discussion being the "Refining of Pulp by Curlation." The speaker of the evening to tell of this process and to lead the discussion of it was one who took an active part in the de-

are your Profits growing "Paper-thin"?



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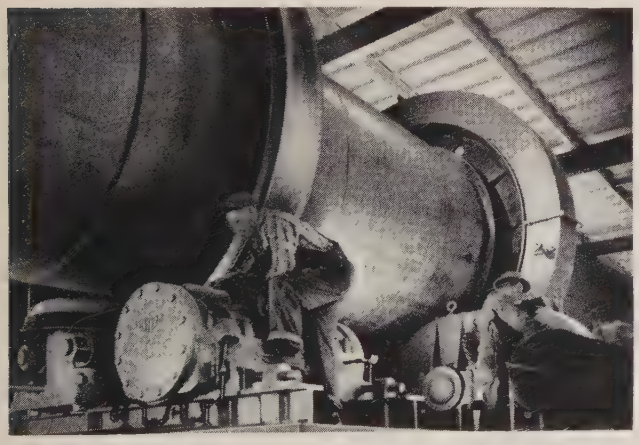
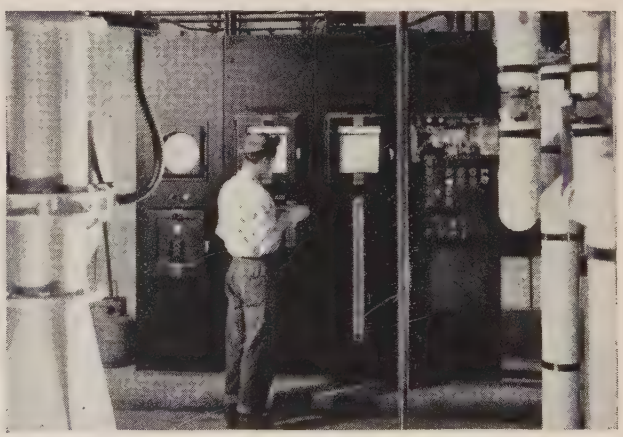


Only routine checking and servicing are necessary to maintain perfect operating conditions for this kiln. Note heavy proportions of the single roller support and thrust roller.



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velopment of the machine to refine pulp in this manner, James Coghill, of the Curlator Corp., Rochester, N. Y.

In his introduction of the speaker, Mr. Lyon related a few of the highlights of Mr. Coghill's experience, among which were his part in the development of the Timken bearing, while with the Dodge Mfg. Co. and his part in the development of the handsheet-making machine, while with the Noble and Wood Machine Co.

Left to right: M. G. Lyon, James Coghill, and Arthur Thurn

Mr. Coghill introduced his very interesting talk by relating how curlated pulp came to the attention of the laboratory staff of the Price Brothers Co., Ltd. mill in Quebec and how the effect was studied by H. S. Hill and his associates there. Mr. Coghill then described the effect curlation has on fibers and on pulp, how this effect may be accomplished by hand and mechanically, and finally he described the Curlator, the machine which has been developed to accomplish it on a production basis. The many unusual properties endowed to fibers and pulp by the process engages one's imagination. This combined with Mr. Coghill's full familiarity with the subject and his frank approach to it, made this an outstanding program.

To complete the evening, Paul Clark of the Crystal Tissue Co., showed a movie film in color, entitled, "The Gift of Tsai Lun." This was presented through the courtesy of the Hammermill Paper Co.

Delaware Valley

The April 27, 1950 meeting of the Delaware Valley Section was held at the Engineer's Club in Philadelphia. Among guests present were R. G. Macdonald, Secretary-Treasurer of National TAPPI and K. P. Goehegan, Vice-President of TAPPI, Vice-President of The Howard Paper Mills, Inc., Aetna Paper Co., Div., the speaker of the evening.

The May 25 meeting, the last for the season, is to be a panel discussion on mill maintenance. Questionnaire's were collected from the 75 members and guests present with requests for subject matter for the discussion.

Chairman John P. Weidner called for a report from the Teller's Committee. Ralph E. Green, Thwing-Albert Instrument Co., Chairman reported that his committee consisting of himself; George H. Detwiler, Calco Chemical Div.; and Frederick W. Goetz, Philadelphia Inquirer, found that the balloting resulted in an overwhelming vote for the slate nominated. These are:

Chairman, A. S. Erspamer, P. H. Glatfelter Co.
First Vice-Chairman, Arthur J. Haug, Scott Paper Co.
Second Vice-Chairman, Harold C. Brill, E. I. du Pont de Nemours and Co.
Treasurer, Frank J. Lovegren, W. C. Hamilton and Sons, Inc.
Secretary, Emil R. Padavic, Container Corporation of America
Executive Committee, John Macadam, National Vulcanized Fibre Co. and John P. Weidner, Container Corporation of America

Glen T. Renegar repeated his invitation to attend the Pennsylvania-New Jersey Division of the Superintendent's Association Spring Meeting at York on May 5 and 6.

R. G. Macdonald congratulated the Penn-Jersey Division on their fine program for the York meeting. He called the attention of the Delaware Valley Section to the Second Testing Division Conference to be held at Rochester on September 13, 14, and 15. He described the type of conference and the work to be done. A highlight of this conference will be the visit to the coating plant of the Eastman Kodak Co. Mr. Macdonald also told of the forthcoming publication of the Routine Methods, a new service of TAPPI to its members. These methods are not to be confused with TAPPI Standard Methods. Members should feel an obligation in taking advantage of these routine methods and submit any others which might be suitable for inclusion. Mr. Macdonald also told of the appointment of Ralph W. Kumler, American Cyanamid Co., as the Section's National Executive Committee Representative.

August S. Erspamer introduced the speaker of the evening, K. P. Geohegan who expressed his pleasure at being able to attend his first of this Section's meetings. He stated that the Ohio Section's meetings were characterized by lively discussions and that he hoped that we would make every possible criticism during the discussion period and make him feel at home. His remarks are as follows:

Pulp Testing

"Ever since the evening in Appleton when I attempted to give a talk on pulp-testing methods, I have been teased about giving a paper that would not be accepted by the TAPPI Editorial Board. Perhaps there is a subject on which I could prepare a paper that would be good enough for the Technical Section of *Tappi.* I don't know what it would be, but I am sure that it would not be on pulp testing.

"Trying to give a talk on that subject makes me think of a notice that I saw on the bulletin board in front of a church in the section near our Aetna mill. It announced that the subject of the next Sunday's sermon would be, 'The World is in a Hell of a Fix.'

"All of you who test pulp are well aware of the confusion in this field and of the many attempts to clarify it. Some of the

Clockwise: W. R. Willets, A. J. Haug, H. C. Brill, G. T. Renegar, A. S. Erspamer, J. P. Weidner, R. G. Macdonald, K. P. Geohegan, E. J. Albert, and C. M. Connor

most brilliant scientists in our industry have made important contributions toward the solution of this problem; so many that it would take too long to try to analyze them, or even summarize them, in this short discussion. Nor am I in a position to offer any new information that will help tie together the many facts that have been discovered.

"In view of that, it seems presumptuous for me to take up your time this evening; and I so expressed myself when I

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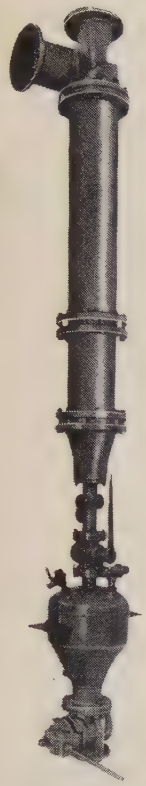

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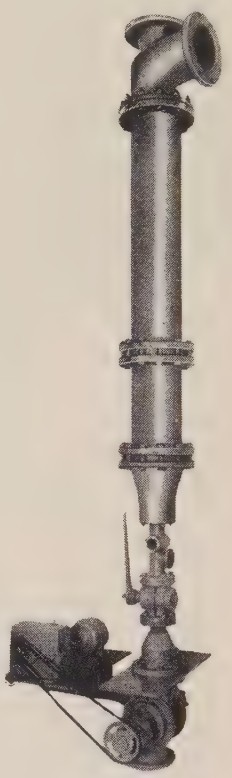

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accepted your invitation. However, there was the possibility that reviewing and restating the problem would bring about a worth-while discussion; and we all have the privilege of arriving at our own ideas of the direction that should be taken by future investigations.

K. P. Geohegan addressing Delaware Valley TAPPI

"When I sat down and tried to arrange in a logical sequence my opinions about pulp testing, I was surprised to find that I arrived at a complete reversal of some of the ideas that I had always taken for granted. Tonight, I would like to lead you along the same line of thought, not with the intent of convincing you; in fact, I rather hope that you will disagree, as a discussion brings with it the possibility of developing valuable ideas.

"Let's start by considering what is wrong with the present methods of pulp testing. The first objection is the lack of standardization and the need of a common basis for evaluating pulp properties. The second is the need for a more accurate and more fundamental basis for predicting the characteristics of paper that can be produced from a given pulp, and the refining treatment that will give the best results.

"Perhaps, it would be well to outline very briefly our experience. I believe that it is a typical example of what has happened in most of the mills throughout the industry.

"When we bought out pulp-testing equipment, we chose the Noble and Wood cycle beater and handsheet equipment because it seemed to offer us certain advantages. We have never regretted it. In fact, we have been exceedingly well pleased; and I wish to make it clear that my criticism of pulp-testing methods does not apply specificially to the apparatus that we chose.

"Our next step was to set up a standard procedure that would duplicate as closely as possible the results that we would obtain on our paper machines. The result is that we can test a sample of pulp and predict with fair success what we can expect when we use it in our three mills. However, it must be realized that one procedure can give only an average of the results that will be obtained on our five paper machines that make such diverse grades as rag bond, sulphite bond, ledger, offset, and index. True, we can make certain allowances for the beating and refining the pulp will receive to make these various grades.

"Another mill, or group of mills, even with the same equipment would almost certainly select a different procedure that would approximate their results more closely. Consider the many kinds of pulp-testing equipment that are offered for sale, and also how many mills use apparatus of their own design. Some, such as book-mills, that depend more on jordans than beaters, have designed miniature refiners to test their pulp.

"Companies that manufacture market pulp are faced with the difficulty that they can not select any method that will give results that will have a meaning for more than a few of their customers. Therefore, many have standardized on the procedures that are most reproducible such as ball-mill treatment and the development of 'maximum Mullen,' neither of which has much significance to the operator of a paper machine.

"So, there are almost as many ways of testing pulp as there are pulp and paper mills. Each company has devised a standard of its own without regard for the fundamentals that are common to all.

"It is much as if each user of coal were trying to buy it on the basis of tests made in a laboratory-size boiler of his own design. We need the sort of tests that correspond with B.t.u. content, per cent ash, and total volatile.

"In other words, we need to learn how to measure what happens to a sample of pulp when it is refined; and then to predict from these measurements what kind of paper can be made from it. We have been trying to take one long leap from the unrefined pulp to the finished paper, instead of taking one step at a time.

"Now, there is nothing new about this. All of you are familiar with much of the work that has been done along this line. But let's follow together in a rough sort of way, some steps that may be taken in this direction.

"What happens in the beater and jordan? I am going to list three things, and then comment on them, even though I realize that they represent an over-simplification. They probably are not even a proper division; but at least they are a starting point: (1) cutting, (2) fibrillation, and (3) 'hydration.' I stated the last with my tongue in my cheek and we will put it in quotes.

1. Cutting. "This appears to be a rather straight-forward affair, although its measurement and evaluation are not so simple.

"Microscopic and projection methods of measurement are tedious. Properly designed classifiers may give us an approximation that will be close enough for our purpose.

"Pulp consisting of long and short fibers will obviously give different results than one of the same average, but uniform, fiber length. Means of 'weighting' the results of fiber-length measurements have been proposed.

"Here it appears worth while to mention that, contrary to general belief, there is much evidence that fiber length has little to do with 'freeness' or drainage rate. Pulps beaten in nonhydrating media have shown little or no change in freeness, as have pulps cut mechanically when dry.

2. Fibrillation. "Just what does this cover? It seems to me that it is a matter of arbitrary definition; and that it may include the raising of small fibrils on the fiber surface, separation into individual fibrils, and even the bruising that tends to loosen the fibrils in the main portion of the fiber.

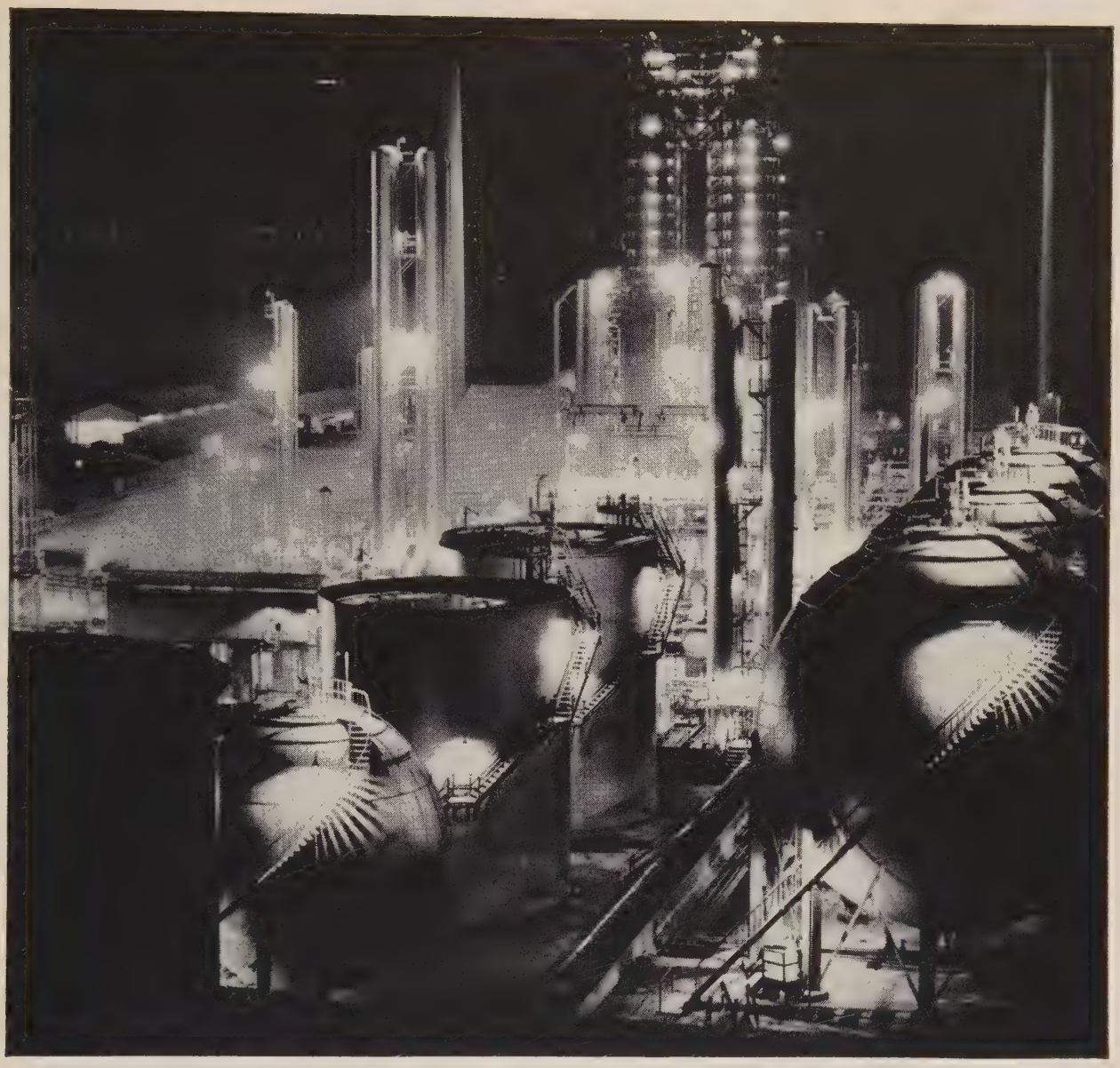
"The determination of 'specific surface' appears to be the logical measurement and, it seems to me, could be taken as the arbitrary basis of definition.

"On the other hand, the method that has been developed for measuring the specific surface is too cumbersome for routine pulp testing. It may be necessary to determine this factor indirectly.

3. "Hydration". "Is there such a thing? I am not sure. I have listed it because it is a traditional concept. Before we go into some of the pros and cons, I am going to be somewhat personal.

"My friend, James d'A. Clark, says that, 'hydration,' as generally conceived, does not exist; and I have a profound respect for his opinion. I feel that he is one of the most original and logical thinkers that I have ever met. Usually when we are together, we get into a stiff, but friendly, argument and, just as usually, I come out second best. It was in such an argument over 'hydration' that I brought up the change that takes place on boiling. That is, if you make a freeness test on a suspension of pulp, then boil it and bring it back to its original temperature, you find that the freeness has increased. Doesn't this represent loss of hydration?

"He explained it on the basis of a drawing together of the fibrils that have been separated by beating. If so, it seems to me that this could be proved by determining the specific surface before and after boiling. Perhaps this has been done although I do not remember having seen any account of it. If not, I think that it would be worth while, not so much to prove or disprove the idea, but to get a better insight into the reason why it is so much harder to beat a pulp that has been dried.



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"Another theory regarding 'hydration' has been proposed by my colleague, C. E. Brandon. It is known that the amorphous cellulose that is present in pulp immediately after cooking, crystallizes when the pulp is dried. He suggests that 'hydration' may consist in reconverting this crystallized cellulose to the amorphous form. So, after all, this third classification is sort of a 'catch-all,' and under this heading we can include whatever has not been included in the other two.

"Let us suppose that we have determined what changes take place in fibers when they are beaten and refined, and that we have developed methods for measuring these changes accurately. How does this information lead us toward the solution of our problem?

"In answer, I am going to offer some suggestions that I know are wide open to the criticism and discussion that I hope they will receive from you tonight.

"In railroad timetables, the maps are drawn as if the train traveled in beautifully straight lines instead of twisting and turning, as we know it does. In this way, attention is focused on the general direction in which the train is going. In the same way, I intend to ignore complexities in order to point out the general direction in which I feel we should proceed.

"In doing so, I wish to lean heavily on the statements and theories advanced by Mr. Clark because, although I do not feel that he has found the entire answer, I am convinced that he has gone far along the right road. At least for the purpose of simplification, I am ready to agree with him that the changes that occur in beating and refining can be divided into two general classes: cutting, and a combination of fibrillation and bruising.

"To measure cutting, he advises the use of a 'weighed average fiber length by true weight' that can be determined by classification or by an optical method that he has devised. As an indirect measure of the second factor, he proposes the apparent density of handsheets prepared according to the standard TAPPI Method. I would prefer a direct measurement on the pulp, itself, if a satisfactory and convenient method can be found.

"According to his findings, each of these factors bears a logarithmic relationship to such sheet properties as burst, fold, tear, and tensile. Using logarithmic paper, these relationships can be plotted to form a straight line, and two points are sufficient to determine the slope that is characteristic of a given pulp. Moreover, the fibrillation-bruising factor bears a similar relationship to the work done on the pulp. Undoubtedly some corresponding relationship holds for cutting.

"Assuming the accuracy of these statements, let us select for our laboratory, two pieces of equipment.

"We will choose one that will do the maximum amount of cutting with the minimum amount of fibrillation and bruising. The laboratory refiner developed by the Mead Corp. is the nearest approach that comes to my mind. From two samples, taken at different degrees of refining, and knowing the power consumed, we determine the proportionality constant that we will call the 'cutting tendency.' Also, we can calculate its relation to the amount of work done on the fibers.

"We will choose the other piece of equipment to give the maximum fibrillation and bruising with as little cutting as possible. Trying to decide what equipment I would select for this purpose, I began to realize why Mr. Clark has recommended the kollergang so strongly. From it, or similar apparatus, we can determine our 'beating tendency,' and its relation to the power consumed.

"Now, we make strength tests on the four sets of handsheets representing the points that we used to determine the two 'tendencies' above. From these we should be able to predict what bursting strength, fold, tear, and tensile we can expect from any degree of 'cutting' or 'beating' or any combination of the two, for the particular pulp that we tested.

"Having done this, it seems to me that we can treat this same pulp in any laboratory beater, take two samples (or possibly three) representing different stages in the treatment, and determine the rate at which this equipment 'cuts' in comparison to the rate at which it 'beats.' Moreover, we should be able to predict the strength tests that we will get from the handsheets.

"Not only that, but we can compare one laboratory beater or refiner with another, or relate their results to those we get in the mill. The problem that we predicted appears to be solved.

"Is this 'so wild a dream?' If so, what are the faults? The over-simplification that I assumed? Isn't that just a matter of degree and of detail?

"Seriously, I feel that the solution of the problem of pulp testing lies in this direction; but an enormous amount of work lies ahead before the goal can be reached."

Discussion

Mr. Geohegan: For testing the properties of pulp we have the TAPPI methods which are standard, umpire methods. Very few mills have complete installations of this standard equipment. That is one reason why the TAPPI Standard Methods are not more fully used.

Arthur J. Haug, Scott Paper Co.: I'd like to clear up a point. Is the apparent density of handsheets related directly to fiber length?

Mr. Geohegan: I am quoting Mr. Clark's work which has appeared in TAPPI publications. He found that more work on the fibers produced a greater density, also that the relationship is "straight-line" when plotted on suitable logarithmic scales. Mr. Clark, in turn, has a series of equations demonstrating how the two factors (cutting, and a combination of bruising and fibrillation) may be used to determine any characteristic.

Mr. Haug: The definition of "apparent density" is the basis weight divided by the caliper?

Mr. Geohegan: Yes.

W. Allan Schenck, Riegel Paper Corp.: Would you go through a hypothetical case?

Mr. Geohegan: These are some of my own interpretations and ideas. A refiner would be used to test the cutting tendency which would be determined as fiber length, L. A kollergang could be used to test the beating tendency which would be determined as specific density, d. If the refiner work was not pure cutting, and the kollergang not pure beating, experience would eventually tell how to weight the results to approximate true "cutting" and "beating."

Then the bursting strength $= KdL$. The proportionality constant, K would depend upon the type of pulp and the amount of power used. This is an oversimplification.

Harold C. Brill, du Pont Pigments Division: Could a ball mill be substituted for the kollergang?

Mr. Geohegan: I don't know. The ball mill may be better, but I have seen it stated that in a ball mill there is more cutting than we realize. I have never used either one.

J. Howard Wright, W. C. Hamilton and Sons: What is the advantage in cutting?

Mr. Geohegan: Simply, that it occurs in all commercial refining and beating to some extent.

Mr. Wright: With the advent of disk refining, beating is done with no cutting and there is only a minimum freeness drop.

Mr. Geohegan: All right, no one would use the disk refiner alone, but the method would still be valid. If one factor did not change that curve would have no slope.

Question: Is there such a thing as 100% fibrillation?

Mr. Geohegan: Without some cutting you would get not only a poor formation but a high expansion rate.

Mr. Wright: Wouldn't it be better if most of the work resulted in a maximum fibrillation with a minimum freeness drop?

Mr. Geohegan: I would still use cutting.

John P. Weidner, Container Corporation of America: What if you could choose pulps according to various proportions of fiber length?

Mr. Geohegan: Then you wouldn't need cutting.

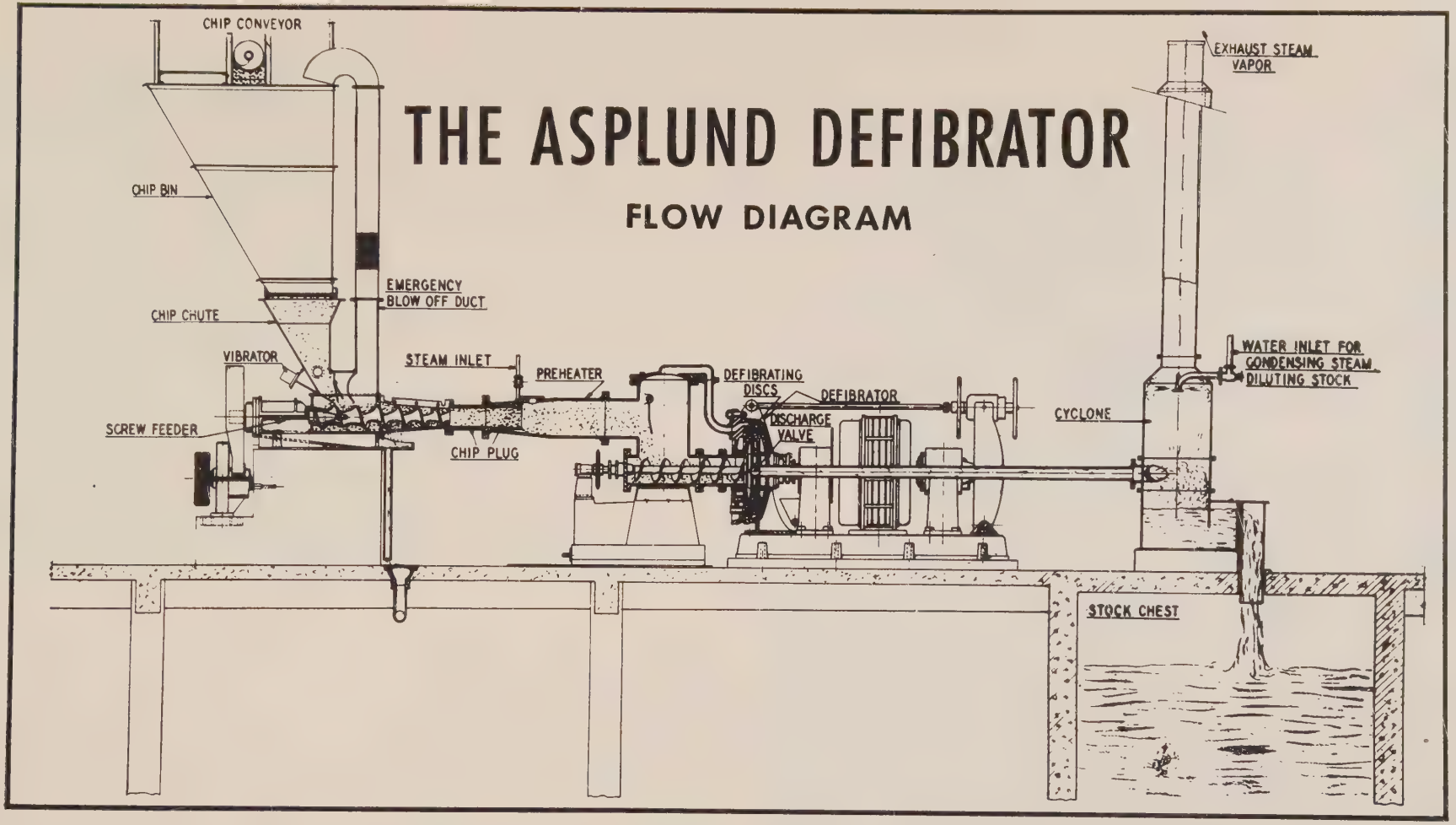
Mr. Haug: Blotting paper is made with as little cutting as possible.

August S. Erspamer, P. H. Glatfelter Co.: Mimeograph papers also.

Question: In considering the straight-line logarithmic function how about the build up and falling off (burst development curve).

Mr. Geohegan: Such a hump does not seem consistent with a straight-line log relationship.

Mr. Haug: What advantage is there in having a classification (fiber length) for any given sheet?



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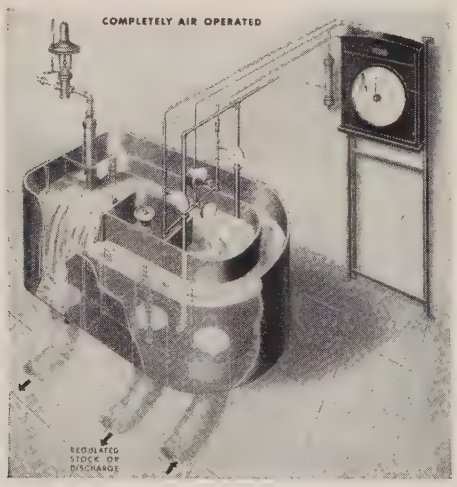

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Mr. Geohegan: I don't know. We don't have a classifier.

Question: Does the tear relationship hold?

Mr. Geohegan: Yes, others too.

Mr. Wright: If refining can be done with less freeness drop then more water can be used in forming the sheet on the machine.

Mr. Geohegan: Several years ago I believed that cutting resulted in a freeness drop. Then I read H. W. Bialkowsky's Institute report describing cutting in a petroleum medium with only a little change in freeness. We had some experiments made by cutting pulp dry with a guillotine trimmer. The fibers were much shorter but there was practically no change in the freeness.

Mr. Wright: I had a similar experience where we found a big drop in the strength but little freeness drop.

Mr. Geohegan: I am very much interested in your description of a disk refiner giving an increase in strength without a freeness change.

Question: This would be similar to beating for glassine?

Mr. Geohegan: Glassine results from the pulp being beaten until it is all separated fibrils. Then the drying and shrinking form the characteristic glassine sheet.

Ellman R. Smith, Union Mills Paper Mfg. Co.: I think the combination of short and long fibers gives the freeness change.

Mr. Geohegan: I agree, though it is much more complicated than that.

Mr. Weidner: We tried to approach a determination of the "beating tendency." In a tissue mill where there is not a large amount of work done on the fiber as compared to other furnishes, we found that a stirring test was satisfactory. A modified British sheet machine stirrer was used in evaluating slush pulps. It was a strength development test with mild action where 3% stock was stirred 30 to 40 minutes. We were surprised at the correlation and reproducibility.

Mr. Erspamer: We found the correlation good between a Waring Blender and the beater.

Mr. Geohegan: According to Clark this would correspond to beating by raising small fibrils on the surface and increasing the fiber to fiber contact.

Question: What do you think of the zero span method?

Mr. Geohegan: The idea is good. The grip of the jaws and other mechanical faults cause results which are not as good as might be expected. It offers possibilities. I have not used it.

Mr. Erspamer: How do you account for the differences in prewar and postwar tests on the same pulp? How do you compare today's pulps with those of ten years ago?

Mr. Geohegan: At first we kept a sample of pulp and tested it from time to time. There was little change in two years. About eight years later we were wondering if our tests had changed when the bearings in our beater had to be replaced. The roll was reground and a retest showed that the changes were within the experimental error. Comparing recent pulps with those produced before the war, we have noticed that, generally, there is a drop in burst and fold, but the tear is higher. We have a lower average burst in all three of our mills. The mills near Appleton have noticed this change, too.

Joseph Paciello, du Pont, Dyestuffs and Fine Chemicals Division: With all the emphasis on the accuracy of pulp testing, how does the effect of the chemical agents in the furnish affect the correlation?

Mr. Geohegan: Pulp testing methods are bound to be crude at the start and we only expect to get trends. Differences in strength due to variations in the amount of size and alum between runs are less than variations in pulp-strength determinations.

Mr. Weidner: If the tests on any lot of pulp are higher or lower than on the previous lot, we expect to find them correspondingly higher or lower on the machine.

Mr. Paciello: Then, in the case of slow-developing pulps both the laboratory test and the mill run will be slow in strength development?

Mr. Geohegan: Yes. During the war we made wet-strength map papers. Our furnish was usually 85% East Coast sulphate, 15% sulphite. The comparable beating curves of the West Coast and East Coast sulphates showed that the West Coast pulp gave a higher maximum burst and fold but the development was slower. To get the strength characteristics desired we found that we could use 100% East Coast Sulphate; but that 20% West Coast Sulphate was the top limit we could use in this furnish.

Question: In considering differences between pre- and postwar pulps how about the influence of pulp production methods?

Mr. Geohegan: This enters in, but is not the whole story. Higher brightnesses, now, and the use of lower quality wood for pulp are contributing factors.

Question: What strength characteristic were you referring to in this prewar comparison?

Mr. Geohegan: We determine the bursting strength and fold on the stock after 15 minutes and the tear and freeness at 45 minutes. This is a stratagem justified by shortened testing procedure and upheld by experience.

FRANK J. LOVEGREN, *Secretary*

Empire State

Western New York District

The annual meeting with election of officers was conducted on May 10, 1950 at Niagara Falls, N. Y. at the Prospect House at 6:45 p.m. A panel discussion on "Slime Control" was the topic. Approximately 70 attended. J. S. Reichert presided.

J. J. Forsythe, chairman of the Nominating Committee presented the slate of officers for the '50–'51 season. A motion was made, seconded and carried that the slate be unanimously approved. The following were duly elected to office:

Chairman: I. V. Earle, Upson Co., Lockport, N. Y.
Vice-Chairman: G. K. Storin, Niagara Alkali Co., Niagara Falls, N. Y.
Secretary: F. Heil, Lockport Felt Co., Newfane, N. Y.
Treasurer: C. S. Taft, International Paper Co., Niagara Falls, N. Y.

The panel was introduced by the moderator, J. J. Forsythe, International Paper Co., Niagara Falls. The panel consisted of R. B. Martin, Wallace and Tiernan Co., Newark, N. J.; W. D. Stitt, Buckman Laboratories, Memphis, Tenn.; H. J. Wilhoyte, Grasselli Chemicals Dept., DuPont, Wilmington, Del.; I. A. Clausen, National Aluminate Corp., Hamburg, N. Y.; and R. S. Shumard, Monsanto Chemical Co., St. Louis, Mo.

"A Conception of Slime and Its Control in the Paper Industry" was discussed by Mr. Shumard who pointed out that "Often 1 gram of slimy mass will contain as many as a billion bacteria." Mr. Shumard drew an analogy between a paper and pulp mill and a living man. "In a broad sense the mill is a living organism, circulating a warm aqueous system and is exposed and beset by constant microorganisms' attack. So is the human body. It lives in a world, day after day, usually without disease because of an innate immunity or resistance.

Left to right, standing: W. D. Stitt, R. S. Shumard, R. B. Martin, I. A. Clausen, and J. S. Reichert. Seated: H. J. Wilhoyte and J. J. Forsythe

The skin of the body acts as a physical barrier against disease organisms. However, if bacteria are introduded into the system through the respiratory system or through a break in the skin, the white corpuscles go after the bacteria, and the antibodies attack the virus. However diseases can occur if the human becomes careless and ingests contaminated food or exposes himself unduly to other sick individuals. This is analogous to a mill employing heavily contaminated water or stock, or to a mill which permits an accumulation of bacteria to gather at various points in a system. By chlorination of make-up water and a good system of housekeeping to remove

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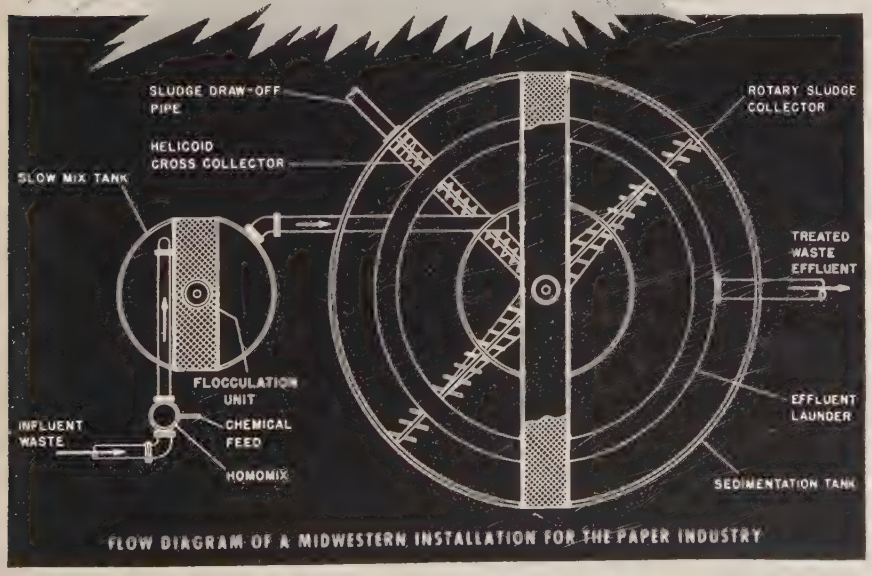

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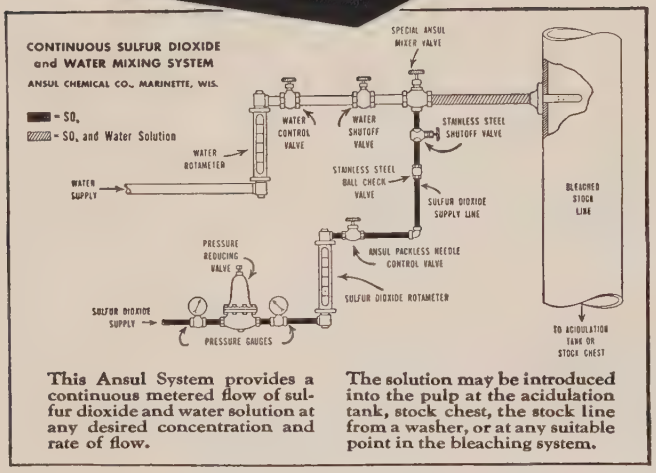

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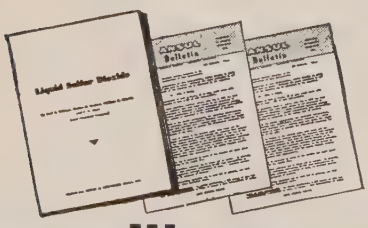

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heavy foci of infection, some outbreaks of slime can be prevented.

"Also a man who wears himself out by loss of sleep, overwork, and so forth, will lower his resistance and become prey for disease. In a paper mill the resistance factors can be considered low pH, high temperatures, and chemicals. Daily addition of bacteriostatic chemicals act as the immunity factor.

"A third type of disease in man, somewhat similar to the first, occurs when a healthy individual with average immunity accidentally through no fault of his own, runs into either a large inoculum of disease organisms or into unusually virulent form. As examples, we have the epidemics, such as flu, infantile paralysis, typhoid, and so forth. So with a mill it will sometimes happen that after operating in a satisfactory manner for years, there will occur a heavy slime infestation. In man, this is counteracted and curbed by rest and drugs. In a mill, a cleanout and heavy dosage of biologically active chemicals will do the trick."

Mr. Shumard reviewed what would be the ideal slime agent and stated that "first, it must be effective and relatively low dosages and be economical. Second, it should impart no appreciable odors to the finished product. Third, it should be reasonably nontoxic to humans who use the end product. Fourth, it should have convenience in handling, ready availability, and impart no color to the finished product.

"The perfect drug for all diseases has yet to be found and similarly, no one ideal chemical has yet been found for slime control. To control slime there have been developed several effective chemical agents. In many cases they are used alternately to complement and supplement one another.

"With antibiosis, the workhorse of this wonderful group of drugs is penicillin. It enjoys more general all-around use than others, such as chloromyciten, aureomycin, and streptomycen. Sodium pentachlorophenate is one of the workhorses of slime-control agents and also fills the requirements of being relatively odorless, relatively nontoxic to man, readily available at a reasonable price, colorless, and water soluble."

Mr. Stitt of Buckman Laboratories spoke on "Slime Control." Mr. Stitt stated, "It has become generally recognized in the control of microorganisms which cause slimes, odors, and sometimes corrosion in pulp and paper mill systems that the employment of toxicants is only a part of the general good housekeeping and sound engineering required to provide outstanding control."

"The first expenditure for toxicant should be for hot toxicant-detergent cleaning of the system at regularly scheduled intervals of 1 to 3 months supplemented by spraying of concentrated toxicants on those surfaces not reached by the toxicant-detergent solution. Areas which are accessible and where slime tends to accrete, such as corroded metal or wooden headboxes, concrete white water chests, etc. should be sprayed with concentrated toxicant at every opportunity. Regular and thorough cleaning and spraying of the system will result in better slime control with lower amounts needed for daily additions to the system. If products containing chlorophenates are employed, the system should be thoroughly flushed with fresh water just prior to the start-up to reduce the possibility of the retention of odor in the first production after the cleaning.

A major problem in the use of toxicants when operating is to provide an adequate amount of toxicant for the necessary period of time in the very large volumes circulated in pulp and paper systems. Slime-control treatment during production in pulp mills is justified only when it has been determined that the losses caused by slime, such as reduced screening capacity, effect on pulp storage characteristics or odor control adequately support the cost of treatment in the pulp mill alone. Spraying and regular periodic circulation of toxicant-detergent solution will usually provide adequate control.

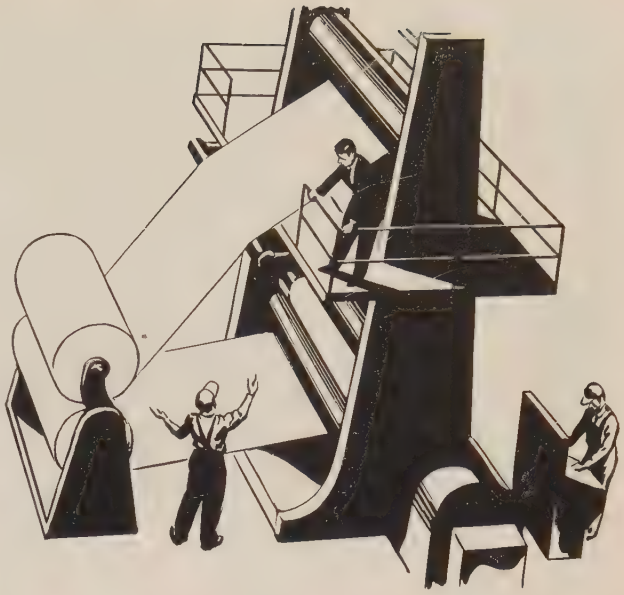
For the control of slime in the paper machine system, pri-

mary emphasis should be placed on the treatment of the large volume of water and fine fibers continually circulated at the paper machine. The toxicants which we manufacture, BSM-11, Butrol, and Bufen 30, are most commonly fed into white water moving to the fan pump for 2 to 3 hours during each 24 hours or for 2 to 3 hours during each 8-hour shift. A desirable alternate employed with fourdrinier machines consists of feeding the toxicant into the lines delivering water to the Bird screen and headbox showers. The amount of BSM-11, Butrol, or Bufen 30 required to provide outstanding slime control ranges from 2 to 25 but usually is between 5 and 10 p.p.m. based on the weight of furnish passing through the headbox during the period of treatment. The ideal amount of treatment to use is that which will assure the maximum net saving above the cost of the toxicant employed.

In most mills the cost of slime control and the far greater losses suffered if slime is not controlled warrants assigning a portion of the time of a careful and experienced workman to supervise and evaluate the program.

The use of slime measuring units on each system is recommended. The data on the amount of slime accreting provide information for use in making comparisons of the effect of slime on operating and quality characteristics and in adjusting the amount of treatment. Because slime usually is composed of mostly water, fiber, and dirt which has been entrained by microorganism and other sticky materials, it is essential that the measuring device to be sensitive to the entraining characteristic. Data obtained from the S-254 slime measuring units have been found to indicate the amount of trouble and loss caused by slime more reliably than indirect methods such as bacterial colony counts. Mills producing fine papers generally have found it profitable to maintain the rate of slime accretion at under 10 grams slime per 1000 sq. cm. per 24 hours. Mills producing newsprint kraft papers and folding boxboard in most cases try to maintain the rate of accretion at 10 to 20 grams slime per 1000 sq. cm. per 24 hours. There are, however, an increasing number of mills producing most types of paper products who are maintaining control at less than 5 grams slime per 1000 sq. cm. per 24 hours. Slime measuring units are supplied at our cost which is $51.50 f.o.b. Memphis, Tenn. or mills may construct units for their own use providing we have a record of the units existence and our name plate is attached. Name plates are supplied without charge. If it is desired to obtain uniform wooden panels, they also will be supplied at our cost which is $51.50 each f.o.b. Memphis, Tenn.

H. J. Wilhoyte spoke on "The Dilemma of Choosing the Proper Slime Control Agent." Mr. Wilhoyte stated, "That the reason for this dilemma arose from the fact that each individual mill has different problems and is apt to have a different assortment of microflora and growing conditions." For this reason, Mr. Wilhoyte stated "each slime control agent can give most effective control at some individual mills and illustrated this condition by presentation of data for seven common slime-control agents, evaluated against for bacteria and six fungi. The microflora chosen for the evaluation included a common assortment of spore and nonspore organisms and representatives of the capsulated type. The study included *Aerobacter aerogenes, Bacillus subtilis, Escherichia coli, Staphyllococcus aureus, Aspergillus niger, Penicillium,* and other species of fungi. Seven representative slime-control agents, identified as A, B, C, etc., were chosen for tests on these microflora. It was noted that slime control agents B and D were the most efficient against *A. aerogenes* and were higher in effectiveness against the similar gram negative bacteria. However, agents A and G were the most efficient agents for controlling *Aspergillus niger*. This can mean, that if you have a preponderance of *A. aerogenes* in your system, the chances are you would get most economical control with slime-control agent B or D. Or if you have a preponderance of *Aspergillus niger* in your system, you are likely to get the most economical control using slime-control agents A or G. From the data



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presented, it was shown that there are some organisms against which two slime control agents give equal control and that in some cases, a difference between the best and next best is quite small.

"This analysis is open to certain questions concerning the choice of agents, choice of species, or indicativeness of machine conditions. We will be the first to recognize the inadequacies, but I believe you will agree that they do not alter the relative effectiveness of the various agents against specific organisms and that the illustration shows what can happen. No single agent is most effective against all microorganisms. Your problem as a chemist or mill man responsible for selecting the best slime-control agent is to find the one which can control most effectively the particular assortment of slime present in your mill. Further, it is the responsibility of the slime-control salesman to help you.

"The most reasonable approach to this problem is to examine critically the information given you to substantiate the claims made and choose the two or three agents which show the most promising of giving economical control and compare them to determine the relative use cost.

"Unfortunately, your troubles in maintaining good economical slime control are not always settled despite the above scientific approach to the problem. We have several articles which have appeared in the literature indicating that on continuous exposure some organisms became so sufficiently acclimated to certain slimicides that they are not effectively controlled. To this extent, the slime problem is similar to certain strains of insects becoming resistant to specific insecticides or the body to sulfa drugs and antibiotics."

I. A. Clausen of the National Aluminate Corp., spoke on "Planning and Adhering to a Slime-Control Program." Mr. Clausen stated, "A mill man once stated that he could no longer afford 'to play at slime control'; he would have 'to work at it.' His meaning was clear. Control treatments had been applied willy-nilly, by trial and error, by inclination or caprice,—in short, in nearly every haphazard way. It was indeed a costly episode, devoid of useful experience for future guidance and barren of significant results."

"Slime control" is no longer a catch phrase, nor is it something remote from the practical business of papermaking. Modern technological advance has shown that slime problems, in their broad implications, tie in closely with mill operation and production. They are intimately associated with other problems, including those of pulp yields, sizing, sheet formation, felt life, foam, pitch, corrosion, odor control, and recovery system. Thus, a modern control program accomplishes far more than slime prevention; it is an accepted procedure for efficient production of pulp and paper under uniformly favorable operation conditions.

As in all programs of major importance, slime control, to be an economic asset, must be "planned." In planning a program for the immediate future and for long-range application, it is helpful to have for guidance as complete a record as possible of mill operation and performance. Such a record should include (a) methods used in handling white water and stock to avoid stagnation, eliminate waste, and improve recovery; (b) data on all chemicals added to the mill system; (c) fluctuations in the condition of water supplies; and (d) significance of growths and deposits found in the mill system. Armed with such a background of useful information the progressive mill operator makes his plans according to a program of control, as follows:

Systematic Cleaning. Instead of going over the same ground during wash-ups, haphazard fashion, whatever cleaning is done is carried out thoroughly and systematically.

Selection and Application of Control Agents. Following a "stem to stern" check up of the mill system plus knowledge of the kinds of microorganisms already established there, the proper control treatments are selected and applied at places and in concentrations best calculated to produce prompt results.

Timing. Many mill men state that they want to develop a program of slime prevention. They have become "fed up" with

hit or miss applications of chemicals which do not provide consistent trouble-free operation. Through cooperative endeavor between mill personnel, field service engineers and the microbiological laboratory, early recognition of signs of potential danger can be determined and suitable preventive measures taken. The control program should be sufficiently flexible to control all degrees and types of contamination which may be present in a system during periods of slime difficulty.

Control Program Applied Regularly and Consistently. Having seen the folly of haphazard applications, mill men will readily appreciate the fact that control carried out inconsistently is not a satisfactory program. In order to develop a program which gets results, it becomes necessary to consider the following basically important steps:

1. Engineering survey comprising a flow diagram, data on mill equipment, data on raw materials, fiber, and chemical furnish used, water tests, water consumption rates, points and quantities of white water sewerage, system temperatures and pH, and description of operation of the mill.
2. Microbiological survey comprising samples at proper points, analyses, classification of organisms, and report on relation of analyses to slime conditions as found in the mill.
3. Selection of treatment depending on types of slime and location of feeders.
4. Application—mill operators instructed in relative dosages of chemicals, methods of feeding, and plant control—is a sanitation procedure developed for each particular mill.
5. Records and control—forms furnished for slime inspection and treatment data. Information supplied on specific methods of control as applied to each individual plant.
6. Service—regular personal calls by fieldman, sending in of sample slurries or slime, finished product and definite program developed to fit changing conditions that might occur due to variation in process, water supplies, or raw materials.

Organisms, always present in a mill system, are ready to grow if given a chance, and experience leads us to conclude that we do not kill off organisms by most chemical treatment; but rather they are inhibitive from growing or are controlled.

R. B. Martin of Wallace and Tiernan Co. spoke on "Chlorination for Slime Control." Mr. Martin stated "that water of the paper mill system must be considered as major pulp or paper-making materials. In the mill system the fresh water may become a raw material of primary importance in the study of slime-control methods. Almost without exception, the groundwood mill location and its selection of a fresh water supply will mean that the waters received in the mill will carry a heavy load of soil bacteria or cellulose-consuming organisms, and an abundant quantity of organic material upon which they feed. These quantities of food materials are, however, meager by comparison with the superabundance of the same foods available in considerable concentration the groundwood mill system itself. Thus, it may be seen that clear spring waters or mountain streams, or even well waters that will show little or no sliming of themselves can still carry into the system enough organisms to thoroughly seed the mill, and to grow and multiply rapidly under these ideal environmental conditions to the point of causing troublesome slime accumulations, loss of production, and of quality of product.

These ideal environmental conditions, in addition to abundant food, include in almost all cases improved temperatures for rapid incubation of the organisms, and occasionally pH ranges that encourage both bacteria and fungi. Mechanically or physically the average mill is so designed or modified or otherwise arranged as to provide further ideal conditions for the seeding of the system and the encouragement of the accumulation of gelatinous or of stringy or rubbery slimes. Once such a system is seeded, slime troubles could persist in spite of the use of a truly sterile fresh water and possibly a truly sterile stock.

It has also been shown that slime infection or mill reinfection can be air borne and may best be guarded against by presenting less favorable environmental conditions or by minimizing opportunity for such seeding or continuing infection by improving storage and ventilation facilities.

This discussion will not consider the physical clarification or the influence of clarification chemicals on the fresh water as a vehicle for seeding or continuing infection of the mill system.

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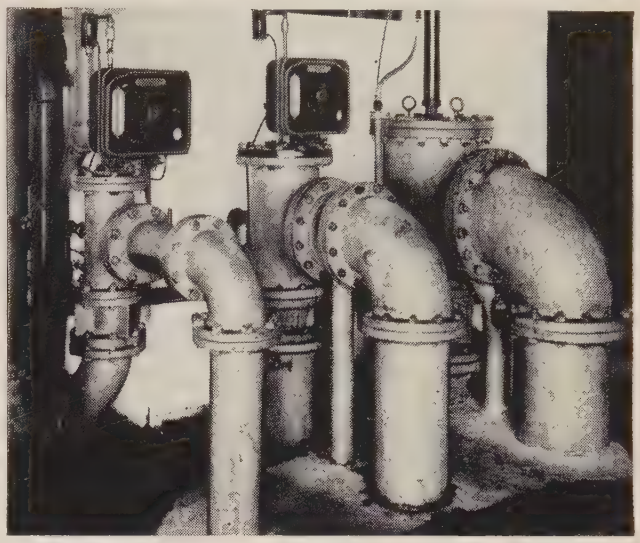

Broke, sulfite, and groundwood meters in a mill of the Ontario Paper Company. Sulfite flow rate is set by paper machine demand as reflected in machine chest level. Groundwood, color, alum, and carbonate are proportioned to sulfite flow rate. Broke flow is under manual control.

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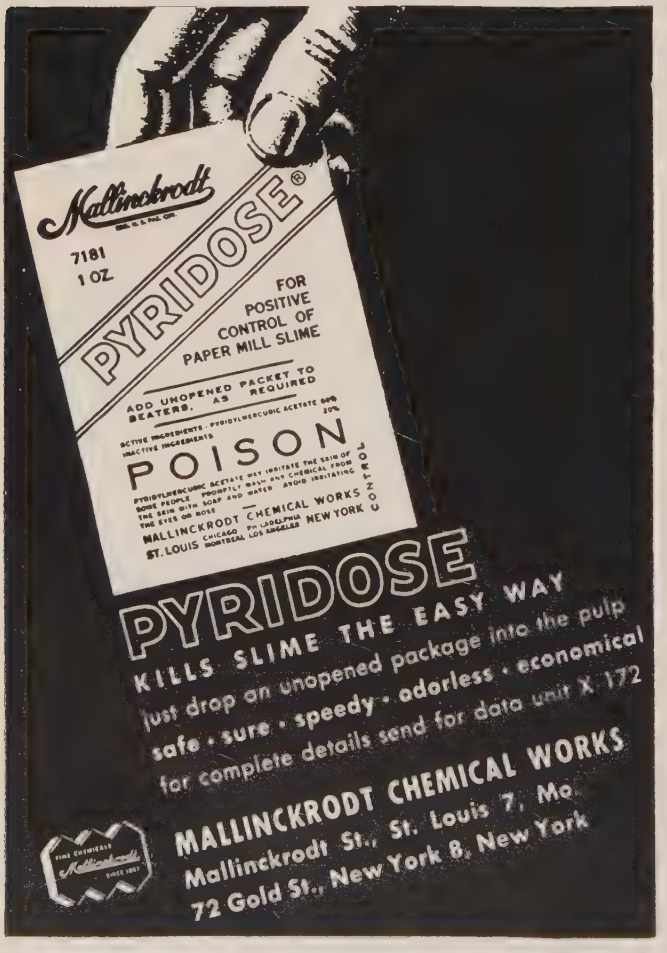
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To a varying degree, such clarification or chemical adjustment may decrease the bacterial load carried into the mill with the fresh water. Occasionally it is found that unfavorable water treatment methods actually aggravate sliming conditions. If the fresh water can be looked on as a vehicle, then chlorine sterilization treatment of the raw water can perform multiple service, by eliminating the slime-forming organisms at their source, improving and making more uniform the chemical, color, odor, and physical clarification, and employing the distribution of fresh water within the mill as a sterile means of diluting seeded slime infection, and also as a means of widespread introduction of residual sterilization effects in an effort to further reduce the numbers of slime-forming organisms being circulated or recirculated in the system. Some further attention will be given later on to the effects of reaction products and other control chemicals.

Contradictory as it may seem, not all sterilization treatments of chlorination applications are designed to produce truly sterile waters. There may be conditions under which it may be necessary to rely on bacteriostatic rather than bactericidal effects. To some degree this choice may depend upon the final uses to which the groundwood pulp may be put, and most certainly will depend upon the nature of operations and system arrangement of the individual mill. Generally, however, there is more to be gained by designing for a complete sterilization, where it is possible to so design, or otherwise to approach as closely as possible to such thorough result as may be in keeping with the available facilities. Thus it is assured that the waters are free of objectionable slime formers, certainly free of pathogenic organisms for the manufacturer of end-use food papers, and frequently, as an incidental, free of objectionable tastes, odors, and color that would detract from suitability of product for food papers or similar end uses.

As white water is progressively utilized to replace former fresh water uses, two consequent reactions take place. The fresh water is no longer the same effective vehicle to carry the sterile dilution of bacterial population into the stock system, and to transmit the killing effect of the free available chlorine residuals to combat seeded slime infection. At the same time the white water has opportunity to return a reinfection to the system and therefore to increase the bacterial population at a greater rate than the indirect fresh water chlorination can reduce the slime infection. One of the first points of white water reuse will be the grinder pits and the bull ditch. Even though the freshly groundwood may be essentially sterile at this point, it is perhaps at its most ideal temperature and pH for rapid incubation of the slime organisms inoculated by the returned white water. It is not surprising, therefore, that slime accumulations will increase rapidly at the rifflers, knotters, and fine screens. As white water may subsequently be used for showers on the bull screens, knotters, fine screens, and for dilution jets, the reinfection tends to pyramid, and it becomes obvious that secondary protection must be provided if the heavy growths and carry-overs in the deckers, thickeners, or wet machines are to be controlled.

The common or most logical source of white water for these purposes would be the discharge from deckers or thickeners. All too often the progressive uses of this white water will mean that separate gravity flows or pump take-offs will be drawn from a common tank or a series of white water tanks. Such a mechanical arrangement makes difficult a uniform effective sterilization treatment of the returned white waters. In a case like this it may be found necessary to apply the corrective treatment to the white water as it enters the tank or tanks, providing the overflow to waste from the tanks is at a minimum, even when pulp is being lapped. When the groundwood is being sluiced to the paper mill, there will be either fortunately a fresh water make-up to the white water system, or less fortunately a return of surplus white water from the paper machines. When this occurs, the opportunity for heavy slime infection multiplies manyfold.

The first necessary step is to endeavor to modify the input or the out-flow to allow a single common point of chemical treatment, and to make sure that no dead areas, no excess volumes, and no bypasses are permitted. If all of these changes are not physically or economically possible, the treatment system and application methods must be redesigned to suit the flume or tank or piping layout that must continue.

Selection of proper sterilization treatment will again depend to some degree upon the end uses of the groundwood pulp or groundwood papers. Until recently only chlorine or chloramines have been acceptable for food papers. There is now some evidence that the Food and Drug Authorities will allow the use of measurably small amounts of mercurials or phenols with the proviso that the applications will not constitute a contamination of the finished product. Mention has been made, for instance, of a top level of 0.1 p.p.m. of mercury. It is natural to suppose that a production suspected of exceeding such an amount would be subjected to critical survey, particularly directed toward the methods and controls used in the application of the corrective chemicals to the stock in process. It would be most convenient to apply these chemicals, either separately or in combination, to the single common point in the recirculated white water system as described heretofore, and in this way to take advantage of the widespread distribution throughout the groundwood system afforded by the reused white water as a vehicle much as the open-system fresh water had served as a multiple-purpose vehicle.

The next logical step is to recognize, by test, or by progressive experience, the specific selective action of the various slime-control chemicals in combating the infecting organisms that may be seeded in the system or may enter with the stock or may be air borne. As experience is extended, it will be determined to what degree chloramines will perform to greater advantage than chlorine alone in the presence of the heavy organic load characteristic of the white water system. If under the conditions of treatment with chlorine or chloramines it develops that additional benefits are needed that can be provided by dispersing agents or by phenols or the mercurials, each of these chemicals must be tested separately and in balanced combination, under positive control, in order that each may be evaluated for its specific selective bactericidal or bacteriostatic properties. Only in this way may the optimum levels of controlled treatments be established with the ultimate purpose being to arrive at a proper economic balance of cost of treatment against operating returns. Experience has generally been that the finally adopted schedule of treatments will utilize a minimum of the more expensive materials, and an increasing usage of the more economical combinations of chlorine, chloramines, phenols, mercurials, and others, aided by the dispersing agents, and by specialized clean-up chemicals and methods, generally in that order of preferential selection.

Failure to recognize these important factors has in the past frequently given rise to a mistaken view of an apparent immunity building up on the part of the infecting slime organism. Each of the known slime formers has a well-established resistance to any one or to all of the commonly used slime-control chemicals. If the levels of treatment are not maintained at or above their established rates of application, or if changes in mill operation or layout are not accompanied by corresponding changes in chemical application, it is simple to see how the surviving organisms may be encouraged to grow at an accelerated rate. It is well recognized that the average mill stock or white-water system represents a mixed suspension of organisms, naturally aggressive toward one another, and tending to keep one another in a form of numerical balance under the conditions existing in the particular environment in which they find themselves. If seasonal, physical, mechanical or chemical changes occur there is a possibility that the control of one or more of the infecting types of organisms may be lost, and these types will develop at excessive rates. If the necessary changes in slime-control applications

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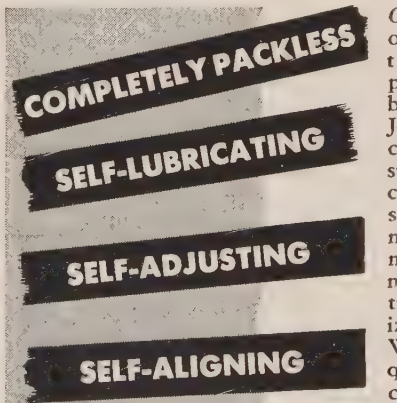

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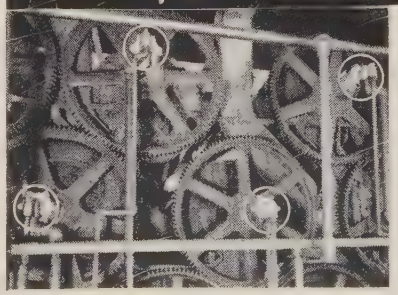

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are not made to suit these new conditions, it may appear to the inexperienced that the original organisms have developed a so-called immunity to the treatments that have in the past been successful, and the unfortunate sequences is that the normally effective treatments are discarded, and unstudied applications of completely foreign treatments will be attempted. These will logically show a temporary shift in the characteristics of the slimes remaining. Ultimately the result is that alternating treatments are set up that attempt to keep the slime characteristics shifting from week to week rather than to recognize and make effective use of the selective actions that are so well demonstrated by the very fact that the different slime characteristics can be in this way controlled or shifted from week to week. At this point a careful evaluation of the relative effects of the alternating treatments will, by experience, yield an efficient, economical, combination treatment that will take full advantage of the selective bactericidal and fungicidal controls of the various chemical applications that have been proved powerful enough to keep the several types of slime-forming organisms under a practical and economic balance. In this way continuous controlled applications of the various slime-control chemicals will prove to be the most efficient means of assuring a slime-free low bacterial count and low cost means of producing a high-quality groundwood pulp, suitable for any ultimate end use such as food container papers, newsprint, or other common application.

J. A. Barath, *Secretary*
Western New York TAPPI

Ohio

The final meeting of the Ohio Section for the current season was held at the Manchester Hotel in Middletown, Ohio on May 11. One hundred and seventy-four members and guests were present.

Chairman Thurn presided and introduced as guests, Ken Geohegan, Vice-President of TAPPI; John Davis, TAPPI Executive Commitee; Dr. Krofta, Black-Clawson representative for Italy; and D. Fogoilio, Fogoilio Paper Company in Milano, Italy.

Mr. Thurn expressed the appreciation of the Ohio Section for the generosity shown by the Shartle Bros. Co. in sponsoring the cocktail hour; to William Biven of Cincinnati Rubber Co. for cigars; and to Mark Magnusson of Titanium Pigment Co. for the lapel cards.

The Chairman of the nominating committee, P. S. Cade reported a slate of officer nominations for the coming year. On acceptance of a motion from the Floor the nominations were closed; and the list nominated by the committee were elected by acclaim.

Officers for 1950–1951 season:

Chairman: Don J. Goodman, Sorg Paper Co.
Vice-Chairman: H. A. Smith, Meade Corp.
Treasurer: R. D. McCarron, Stein-Hall Co. Inc.
Corresponding Secretary: Paul Clark, Crystal Tissue Co.
Recording Secretary: M. G. Lyon, Champion Paper & Fibre Co.

Members of Executive Committee:

Arthur Thurn, Champion Paper and Fibre Co.
P. S. Cade, Harding-Jones Paper Co.
D. M. Yost, Sorg Paper Co.
S. R. Holmes, Gardner Board and Carton Co.
C. D. Roess, Wrenn Paper Co.

The elected Chairman, Mr. Goodman, expressed his appreciation for and admiration of the leadership given the Ohio Section during the past year by Arthur Thurn.

Mr. Goodman introduced the U.T.C. Quartet which ably presented five song numbers.

Executive Committee, Ohio Section, 1950–51 Left to right Seated: Malcolm Lyon, Champion Paper & Fiber Co., Recording Secretary; Paul Clark, Crystal Tissue Co., Corresponding Secretary; Donald Goodman, Sorg Paper Co., Chairman; Robert McCarron, Stein, Hall, & Co., Treasurer; and Herbert Smith, Mead Corp., Vice Chairman.

Standing: *S. R. Holmes, Gardner Board & Carton Corp.; John Davis, Mead Corp., Nat'l Executive Committee, TAPPI; Ken Geohegan, Howard Paper Mills, Nat'l Vice President, TAPPI; * Arthur Thurn, Champion Paper and Fiber Co. and Phil Cade, Harding Jones Paper Co.

**** Executive Committee, Ohio Section. Other members not on picture are Carl Roess, Wrenn Paper Co., and D. M. Yost, Sorg Paper Co.***

Following the numbers sung by the U.T.C. Quartet, the TAPPI men were entertained by a talk on Alaska presented by R. J. Anderson of the Battelle Memorial Institute. Dr. Anderson traced the history of the purchase of Alaska, described its geography, climate, mining and fishing industries.

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REPORTS AND DISCUSSIONS

Presented at National and Regional Conferences

Chemical or Solvent Cleaning of Boilers

The following is a report of the informal talk given at the Steam and Power Committee Round-Table Session at the Fourth Engineering Conference of the Pulp and Paper Industry, held at Boston, Mass., on Nov. 1, 1949. M. F. Schnaufer, Chief Engineer of the Detroit Sulphite Pulp and Paper Co., presided as discussion leader.

C. W. Groom of Dowell, Inc., discussing "Chemical or Solvent Cleaning of Boilers" said, in part:

"Chemical cleaning is essentially the filling of a boiler with a predetermined liquid solvent, allowing it to soak or circulating it for a definite time, and then draining and flushing.

"Chemical cleaning is a maintenance toll which replaces or supplements mechanical cleaning methods. Its use is based upon definite specifications, a knowledge of which is necessary to make effective use of this maintenance tool. This discussion is limited to the fundamentals of chemical cleaning.

"To clean boilers chemically there are just four factors with which we have to be familiar. These include the scale deposits, the solvent, the conditions of application, and the hook-up.

"Over one hundred chemical compounds have been identified in boiler scale deposits, but for our purposes the deposits can be separated into classes based upon their chemical reactions. The deposits are as follows:

Water deposited	Carbonates, phosphates, silicates, and sulphates
Corrosion products	Oxides
Organic	Oil and greases, tannin, and lignin

"One type of solvent will not remove all of the deposits. Although hydrochloric acid is the solvent most generally used, it is usually altered by the use of different additive agents. Alkaline-type solvents such as soda ash, trisodium phosphate, etc., are also used. In a number of cases, where organic type deposits are to be removed, various hydrocarbons such as kerosene and diesel oil, and chlorinated solvents such as carbon tetrachloride are used.

"The various types of solvents generally employed are:

Acid type	Hydrochloric acid, HCl + wetting agent, and HCl + itensifier
Alkaline type	Soda Ash, tri-sodium phosphate, caustic Soda, and sodium meta silicate
Organic type	Hydrocarbons and chlorinated solvents

It is because of the wide variety of solvents used that the operation is entitled chemical or solvent cleaning rather than acid cleaning.

"Hydrochloric acid is most generally used because it dissolves most of the scales. In its natural state it also reacts with iron, copper, and other metals resulting in corrosion. This corrosive reaction can be controlled by the addition of various types of materials known as inhibitors. The addition of an effective inhibitor decreases the action of the hydrochloric acid on the metals down to a safe amount.

"The use of inhibited hydrochloric acid in removing scale deposits from boilers is due to a chemical reaction between the acid and the scale deposit. For example, the reaction of hydrochloric on calcium carbonate scale is shown by the following chemical equation.

$$CaCO_3 + 2HCl = CaCl_2 + H_2O + CO_2$$

"Effective chemical cleaning is accomplished by using conditions which drive this reaction to completion. Increasing the acid concentration, increasing the temperature, vigorous agitation, and increasing the time all help to expedite the reaction. However, each condition has a limiting factor. If the concentration is too great, inhibition is not as effective. Therefore, the concentration of the acid is kept below 15% and generally runs between 5 and 10%. The same is true of temperature. Corrosion can occur if the temperature is too high, therefore, the maximum temperatures used run around 165°F. with most cleaning operations done at 150°F. and less. Agitation in boiler cleaning can be obtained only by circulation. The size of a boiler would demand an extremely large pump to obtain agitation or circulation through each tube. However, circulation is generally unnecessary in boiler cleaning as there is enough natural circulation to keep the solvent mixed. Most boiler cleaning operations are carried out without any circulation. The time of soaking is generally from 4 to 8 hours.

"The illustration shows a typical hook-up used in cleaning a water tube boiler. A vent is provided by attaching a hose to the air vent and discharging it at a safe distance from the boiler. A solvent input line is provided from the solvent truck to a blow down or hand-hole opening. Concentrated solvent containing all of the addition agents is transported in a specially equipped mobile truck. Water for diluting the concentrated solvent to the proper concentration is added through a proportioning header. The temperature of the ingoing solvent is obtained by running steam into the solvent line through a special steam heater.

"Although this discussion is limited to boiler cleaning, it should be pointed out that other equipment is just as readily cleaned by chemical means. This includes pipe lines, heaters, condensers, engine jackets, evaporators, filter beds, and water wells. Practically any type of undesirable coating can be removed from any type of industrial equipment.

"In closing we repeat that chemical cleaning is in reality a boiler maintenance tool readily available to the operator. It can be used effectively where there is an understanding of the basic factors: the scale to be removed, the solvent, the hook-up, and temperature and time of contact.

Discussion of Mr. Groom's Comments

H. R. Arnold, Union Bag & Paper Corp: Do boiler manufacturers recommend the solvent cleaning method for removing mill scale?

C. H. Groom, Dowell, Inc.: The removal of mill scale is necessary whether it be at the mill or after erection. Using solvents seems to be the only thorough way to remove mill scale from a modern boiler. Probably no boiler manufacturer specifically recommends removal of mill scale with solvents but as most of the mill scale work we receive comes direct from the manufacturer, they recognize it as a good engineering practice.

Note: A. Mortenson, St. Regis Paper Co., stated that the boiler manufacturers are recommending the acid method for removal of mill scale. Mr. Mortenson's experience with the acid method was that it gave excellent results whereas with previous methods, the results have been very poor.

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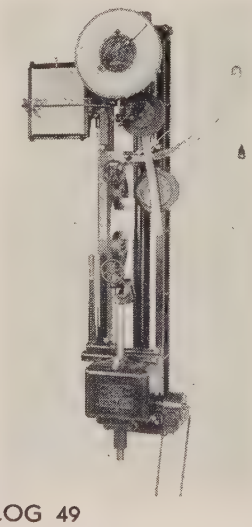

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Standard of the World

B. M. Turner, International Paper Co.: With the acid method, are there any hazards involved?

Mr. Groom: The only serious hazard involved is that during the chemical cleaning some hydrogen gas is given off. This gas, if not properly removed, is explosive. The hazard is entirely eliminated by properly venting the boiler, which is done on every cleaning operation.

M. H. Dixon, St. Regis Paper Co.: How much success has Dowell had in removing silicates?

Mr. Groom: Silicates are difficult to remove. They are often so hard and dense that they cannot be removed mechanically. We have a solvent which dissolves these hard silicates and have been particularly successful in removing them.

Mr. Dixon: Have you ever used the solvent method to clean driers on paper machines?

M. F. Schnaufer, Detroit Sulphite Pulp and Paper Co.: We have been using this method with good results to clean driers.

Mr. Schnaufer went on to say that in his plant they were intending to use the solvent method of cleaning more and more, and that he knew of no other method to clean the new type boilers.

M. S. Fogerty, Sutherland Paper Co.: How often does a boiler need cleaning?

Mr. Groom: It depends upon the local conditions at a plant. The average is about once every two years.

M. F. Schnaufer: With the acid method, is forced circulation necessary on heavily scaled or sludged boilers?

Mr. Groom: Forced circulation is not necessary. Natural circulation will give adequate distribution of the solvent.

W. Wyburn, Federal Paper Board Co.: Can cast iron be cleaned with this method?

Mr. Groom: Yes.

M. F. Schnaufer: How are your prices determined?

Mr. Groom: The price of Dowell Service is based upon the amount of chemicals required, the equipment used, and the time involved in doing the complete operation.

Note: Mr. Schnaufer gave an example of the experience he had had. On a 100,000 lb./hr. boiler, the total time the boiler was down for the cleaning operation was six hours. The price was $780.

LETTERS TO THE EDITOR

New Supply-Demand Data

To the Editor, *Tappi*

When the first article in the series, "Supply-Demand Data on Chief Nonfibrous Raw Materials Used in the Pulp and Paper Industry" was sent to *Tappi*, the Bureau of Census had not published its data on chemical consumption by industries for 1947. Data for 1948 and, in some cases, for 1949 are now available. This letter supplements the data in the published articles. It should be stressed that the articles will be of value only as the data are kept current and corrected by revised and additional information as it becomes available.

Chemicals Used in the Manufacture of Pulp (Tappi, November, 1949)

Data for 1948 are available for Table I. *Chemical Engineering* (February, 1950) carries the index which shows that the pulp and paper industry is still the third largest consumer of chemicals, with the fertilizer and rayon industries first and second.

Sulphur data for 1949 are now available (4,750,000 long tons) and should be added to Table III).

In Table IV (Caustic Soda Consumption), the estimate for 1947 should be replaced by the firm figure reported by the Bureau of Census [The Census of Manufacturers 1947, MC28A, Industrial Inorganic Chemicals (1949)]. The editors of *Chemical Engineering* (February, 1950) have revised their 1948 estimate and have given an estimate for 1949. The changes are as follows:

Caustic Soda Consumption (Data in 1000 Short Tons)

Date	*Total*	*Pulp and paper industry consumption, %*	
1947	2130	160	7.5
1948	2357	176	7.5
1949	2200	170	7.7

The statement in the text that "no official Census data exist" for caustic soda and soda ash is true when exception is made for 1947 Census figure.

The Bureau of Census gives the pulp, paper, and paperboard consumption of chlorine as 246,961 short tons for 1947 and this figure should replace the estimate made for that year in Table VII. In view of the Census figure, the 1948 estimate would seem to be too low.

The Bureau of Census gives the 1947 consumption of soda ash for the pulp, paper, and paperboard industry as 259,447 short tons and the editors of *Chemical Engineering* (February, 1950) give revised estimates for 1948 and an estimate for 1949. These should replace the data in Table IX.

Soda Ash Consumption (Data in 1000 Short Tons)

Date	*Total*	*Consumption by pulp and paper industry, %*	
1947	4800	259	5.4
1948	4872	230	4.7
1949	4100	200	4.8

The Bureau of Census gives the 1947 consumption of salt cake by the pulp, paper, and paperboard industry as 619,047 short tons, an amount under the estimate made in Table X. Because of this Census figure the estimate for 1948 is probably too high. This may be the result of a lower consumption per ton of kraft pulp than was used in the estimate.

Limestone data are now available for 1948 from the Bureau of Mines and should be added to Table XIII. Total production of limestone (all uses) was 222,526,000 short tons; paper consumption of limestone as stone and as lime was 1,872,000 short tons which is 0.84% of the total. The pulp and paper industry consumed 476,000 tons as stone and 698,000 tons as lime, which was 9.6% of the total lime consumption.

Inorganic Papermaking Chemicals (Tappi, December, 1949)

In Table V the possible paper industry use of titanium dioxide was estimated from a use percentage published in the 1946 Minerals Yearbook. Several suppliers believe that this estimate is much too low even for 1946 and the consumption has increased in the last three years. It is possible that the 1946 estimate is only about half of the present consumption but there are no official data as yet to show accurately titanium consumption by industry.

In Table VII on Gypsum Products Sold or Used in the United States, 1947 and 1948 data are revised as follows:

Use for Building Papers and Boards (Data in 1000 Short Tons)

Date	*Supply*	*Wallboard*	*Sheathing*	*Laminating*	*Total*	*Percentage*
1947	5459	1699	112	1.9	1812.9	33.3
1948	6812	2103[a]	138	...	2241	33.0

[a] Includes laminating board.
Source: Minerals Yearbook, 1948.

In Table VIII on synthetic barium sulphate sold or used in the United States, 1948 data should be added from the Minerals Yearbook (22,733 short tons).

Organic Papermaking Chemicals (Tappi, January, 1950)

In Table VII an estimate could be added for the year 1948 on glue production based on the Bureau of Census data for the first half of the year. Data were not collected for the second half. The estimate for 1948, based on the first six months' report, is 149,184,000 pounds, a reduction from the high level of 1947.

RUTH E. SHALLCROSS, Research Associate
The Institute of Paper Chemistry, Appleton, Wis.

Straw pulp

To the Editor, *Tappi*

I read, with great interest, the Report of the Northern Regional Research Laboratory (March 18, 1948) by Dr. Aronovsky.

In this connection with the work at our Venizel Mill we always made wheat straw pulp for 9-point in our globe rotary digesters with 1.8 times the weight of water. The cooking required four hours at 57 p.s.i. Based on the wheat straw we used 7% lime (CaO) and 6% soda ash. We call the product "seconda straw pulp."

I should like to make tests at the laboratory of our plant

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using a 2.5 ft. diam. globe rotary digester to make "prima straw pulp" of much higher grade.

It is my intention to make these tests with 8 to 4% caustic soda and 4 to 8% neutral sulphite (based on the weight of straw). The aim would be to make a "prima straw pulp" which, with a blending with semichemical wood pulp would make a fairly strong board for container liners.

The cooking would not be made separately but the beating of each pulp would be separate. At our Venizel Mill the order of beating is a breaker beater, a Claflin refiner and three hollander beaters.

I would be grateful if you would advise me regarding the aforementioned project.

Georges Franck, 31 Rue de Constantine, Paris 7, France

Dr. Aronovsky's Response

Dear Mr. Franck:

R. G. Macdonald, secretary of TAPPI, has referred your very interesting letter of March 7 to me for reply. You will, of course, recall that we had some previous correspondence on pulping straw dating back to 1947. We have done a considerable amount of work on pulping straw since that time and are glad to enclose reprints of several articles published from this Laboratory relating to the subject.

With regard to producing your so-called "seconda straw pulp" we have now found that a stronger and stiffer paper can be made by replacing lime with caustic soda or with sodium sulphite or with blends of the two. The article describing this work will be published in *Tappi* this year. In the meantime we are glad to enclose a mimeographed copy of this manuscript.

With regard to your "prima straw pulp" the highest yields obtained in pressure cooking come from the use of 8 per cent sodium sulphite and 3 per cent soda ash, based on dry straw. The cook may be carried on for two hours at 170°C. (100 p.s.i), four hours at 160°C., or eight hours at 150°C. This will produce a screened pulp (through an 8-cut plate) with a yield of approximately 53 per cent, based on dry straw. This pulp can be bleached with 5 to 7 per cent chlorine by the 3-stage process to give a yield of about 50 per cent of bleached pulp, brightness 70, based on original dry straw. This pulp has strength values at least fully as good as that of bleached sulphite wood pulp with the exception of a relatively low tear resistance.

Pulping with caustic soda or with kraft chemicals under these same conditions produces 44 to 47 per cent of unbleached screened pulp and 40 to 43 per cent of bleached pulp. The soda and kraft wheat straw pulps, however, have even better strength than the neutral sulphite pulps.

A much preferred method of pulping, however, is the mechano-chemical process described in one of the enclosed reprints. For the production of the "seconda" type of straw pulp the time of cooking at atmospheric pressure is one hour or less as compared with five hours at 40 p.s.i. using the same types and amounts of chemicals based on straw. For the "prima" type pulp a strong, easy bleaching pulp is obtained in one-half hour by the mechano-chemical process with 10 to 12 per cent soda or kraft chemicals, based on dry straw. The pulp yields from the mechano-chemical process are considerably higher than those obtained from pressure cooking. The nodes are softened and swollen but not defibered in this process. For the "seconda" pulp the nodes and rachises can, of course, be refined and incorporated with the pulp while for the "prima" type these nodes and rachises are easily removed by screening and riffling.

The whole, unchopped straw in bales with the wires removed can be charged directly into the Hydrapulper. This method is preferred for the seconda type of pulp. For the finer pulp it is preferable to chop and dust the straw previous to cooking. The general procedure for producing the coarser pulp is: Charge straw into hot liquor in the Hydrapulper containing the chemical, operate the unit until the desired quality of pulp is obtained as is evidenced by sampling, wash the cooked pulp and defiber in the average refining equipment.

It will not be necessary to use a breaker beater since the straw is chopped as well as cooked by the action in the Hydrapulper.

For fine straw pulp the chopped straw is charged into the hot liquor and chemical in the Hydrapulper and after cooking the pulp is washed, preferably on a vacuum filter. The washed pulp may then be returned to the Hydrapulper and circulated with water for a short period to completely defiber the material. The pulp is then sent over a riffler and screened, preferably on flat screens (about 8 cut). The screened pulp is then ready for bleaching and refining.

The mechano-chemical process is not suitable for use with sodium sulphite since the latter is a gentle pulping agent and requires higher temperatures than are obtained at normal pressure. Lime, caustic soda, sodium sulphide, or similar strongly alkaline liquors are quite satisfactory. I should also like to point out that the ordinary commercial Hydrapulper designed for pulping waste paper or dry pulp has a relatively small rotor compared with the size of the tub. For pulping purposes a larger rotor is very desirable so as to give the stock a higher peripheral speed. The manufacturers of this equipment are aware of this fact and have designed units with larger rotors for pulping straw and other agricultural residues.

S. I. Aronovsky,
Northern Regional Research Laboratory, Peoria, Ill.

EMPLOYMENT SERVICE

Positions Open

P68-50. Technical service man for paper coating field. Young chemist or chemical engineer, 1 or 2 years' experience in paper coatings or paper mill.

P69-50. Chemical manufacturer requires services of man with technical training and several years' experience in paper manufacture to handle technical service work in connection with an extended line of chemicals used by the paper industry. Should preferably be between 25 and 35 years of age. Will be required to travel to paper mills within given area and after securing proper training and experience should be qualified to discuss mill problems of a chemical nature with paper mill executives. Our men know about this advertisement.

P70-50. Man with either or both sales and manufacturing experience to handle new operation for us that would include polyethylene and other coating of paper.

P71-50. Assistant superintendent for kraft paper mill in New York State.

P72-50. Chemist or technical supervisor for two machine board mill in Indiana. Recent college graduate with some paper mill experience preferred.

P73-50. Converter wants man who will be responsible for procuring and setting up paperboard specifications with suppliers. Should be about 30 years of age and have a chemical background with practical paper mill experience.

Positions Wanted

E73-50. Plant engineer, 42, with 20 years' experience in construction, design, and maintenance. For 9 years chief engineer of a board mill and carton plant.

E74-50. ME, 10 years' project experience in design, operation, and maintenance of packaging machinery, lower-cost production methods, motion study, machine and workplace layout, packaging materials, container design.

E75-50. Graduate N. Y. State College of Forestry, 33, family. Diverse development experience in pulping, pharmaceuticals, process equipment. Desires position as chemist with progressive paper mill.

E76-50. Industrial Engineer, 29, family. B. S. degree. Four years service and sales engineer for instrumentation in pulp and paper mills. Also production control and marine power plant experience. Desires position in either production or mechanical department of northern pulp and paper mill.

UNITED STATES PATENTS ON PAPERMAKING

Fourth Quarter, 1949

Compiled by CLARENCE J. WEST

The following list of patents has been compiled from the current numbers of the Official Gazette of the United States Patent Office. Because, as a rule, only one claim is published in the Gazette, it is not claimed that the list is complete; also, it is possible that the list may contain some patents that do not apply specifically to pulp and paper manufacture.

Copies of any of the following patents can be obtained from the United States Patent Office, Washington 25, D. C., by sending twenty-five cents for each patent desired.

October 4, 1949

2,483,464. Container. Alexander H. Johnson, assignor of one half to Frederick T. Johnson, Milwaukee, Wis. Filed Dec. 4, 1945. 1 claim. (Cl. 229-22.) A container has a triangular cross section which provides strength and permits the containers to be nested.

2,483,481. Shipping carton. John C. Stetson, assignor to John C. Stunkel, Chicago, Ill. Filed June 21, 1946. 2 claims. (Cl. 229-49.) A corrugated shipping container is provided with reinforcing members to strengthen the walls.

2,483,533. Combined shipping and display container. Betty V. Dubiner, Toronto, Ontario, Canada. Filed April 9, 1945. 2 claims. (Cl. 206-45.19.) A standard knock-down, end-opening container is used for shipping and displaying commodities.

2,483,559. Process of preparing vanillic acid. Irwin A. Pearl, assignor to Sulphite Products Corporation, Appleton, Wis. Filed May 29, 1947. 6 claims. (Cl. 260-521.) Vanillic acid is obtained by oxidizing a lignin compound with silver oxide in the presence of sodium hydroxide.

2,483,583. Multiple compartment box. Wilbur W. Holes, St. Cloud, Minn. Filed Dec. 23, 1946. 12 claims. (Cl. 229-28.) A multiple compartment cardboard box is adapted to be shipped, knocked down and readily assembled.

2,483,604. Container and method of making the same. Alvin A. Abramson, assignor to Central States Paper & Bag Company, St. Louis, Mo. Filed June 24, 1944. 6 claims. (Cl. 93-35.) Methods are provided for the high-speed mass production of waterproof laminated paper bags from a continuous roll of flexible sheet material.

2,483,605. Apparatus for manufacturing containers. Alvin A. Abramson, assignor to Central States Paper & Bag Company, St. Louis, Mo. Filed Sept. 12, 1945. 1 claim. (Cl. 91-55.) Equipment is provided for forming waterproof laminated paper bags from flexible sheet material.

2,483,607. Egg packing material. Torris H. Alfreds, assignor to Mapes Consolidated Manufacturing Company, Griffith, Ind. Filed Dec. 7, 1946. 7 claims. (Cl. 217-26.) A molded pulp pad for egg crates is provided with pickup projections which facilitate annual handling of the pad from above.

2,483,797. Tall oil acid composition. Edward A. Van Valkenburgh, Greene, N. Y. Filed Nov. 23, 1948. 6 claims. (Cl. 106-123.) The composition consists of 80–90% of a mixture of free tall oil acids and aliphatic amine soaps of these acids and 10–20% of a compatible liquid hydrocarbon solvent.

2,483,806. Waterproof concrete composition. Walter D. Buckley and Paul E. McCoy, assignors to Stancal Asphalt & Bitumuls Company, San Francisco, Calif. Filed Sept. 18, 1946. 10 claims. (Cl. 106-96.) An oil-in-water bituminous emulsion for use in waterproof Portland cement and the like contains 0.25 to 2% alkali lignin.

2,483,860. Machine for application of sleeves to valve bags. Edric W. Vredenburg, assignor to St. Regis Paper Company, New York, N. Y. Filed July 31, 1945. 5 claims. (Cl. 93-8.) A machine is provided for applying supplemental sheets to valved kraft paper bags to form sleeves in the respective valves.

October 11, 1949

2,484,046. Method of treating scale forming liquors. Carl H. Nyman, Stockholm, Sweden. Filed March 2, 1943. 1 claim. (Cl. 260-124.) A finely dispersed suspension of calcium sulphite is established in the liquor, the liquor is heated, and the calcium sulphite particles are allowed to settle out with the scale-forming components. The resulting scale is removed with weak acid solutions.

2,484,047. Apparatus for forming sheet products from paper pulp. Eugene L. Perry, assignor to Paper Plastics Products Corporation, Bloomfield, N. J. Filed May 29, 1945. 3 claims. (Cl. 92-43.) A paperboard sheet is formed of the desired thickness without having either the weakness usually inherent in thick sheets or lack of cohesiveness between layers.

2,484,085. Collapsible carton. David Golder, New York, N. Y. Filed March 20, 1946. 3 claims. (Cl. 229-29.) An egg carton is provided with inwardly or outwardly foldable end or side walls.

2,484,167. Hat packing stay. Joseph G. Huye, assignor to Huye Space Saving Box System, Inc., New Orleans, La. Filed Oct. 15, 1945. 4 claims. (Cl. 206-9.) A paperboard hat-packing stay is provided with bracing elements.

2,484,390. Apparatus for folding paper and like material. James W. Thorpe, Sydney W. Bussell, and Sidney J. Herbert, assignors to H. Reeve Angel & Co., Ltd., London, England. Filed Feb. 25, 1949. 9 claims. (Cl. 93-86.) The operation of the folder is described.

2,484,402. Process for producing chlorine dioxide. George A. Day and Edward F. Fenn, assignors to Brown Company, Portland, Maine. Filed Jan. 4, 1946. 17 claims. (Cl. 23-152.) Chlorine dioxide is prepared by the reaction of sodium chlorate and hydrochloric acid.

2,484,473. Paper machinery. Stephen A. Staege, assignor to The Black-Clawson Company, Hamilton, Ohio. Filed Oct. 11, 1946. 14 claims. (Cl. 74-241.) An automatic operating control is provided for guiding a Fourdrinier wire or felt to maintain its operation in the proper path of travel.

2,484,483. Polytetrafluoroethylene dispersions. Kenneth L. Berry, assignor to E. I. du Pont de Nemours & Company, Wilmington, Del. Filed July 26, 1945. 9 claims. (Cl. 260-32.8.) Dispersions of tetrafluoroethylene copolymers in ketones and esters of dicarboxylic acids are useful for the impregnation of paper and the like.

2,484,608. Lightweight container. La Verne E. Cheyney and Robert J. McCutcheon, assignors to Wingfoot Corporation, Akron, Ohio. Filed Nov. 30, 1945. 1 claim. (Cl. 229-14.) The container consists of rubber hydrochloride and lightweight insulating material and can be enclosed in a snugly fitting cardboard container.

2,484,641. Method of separating adhering sheets by an air blast. James T. O'Hara, assignor to Western Electric Company, Incorporated, New York, N. Y. Filed Oct. 12, 1945. 2 claims. (Cl. 271-26.) An impregnated laminated paper insulating bar is subjected to a controlled jet of air which has sufficient strength to separate the material into its individual sheets.

2,484,676. Apparatus for drying paper. George L. Bidwell, Riegelsville, Pa. Filed Nov. 21, 1946. 6 claims. (Cl. 34-111.) An apparatus is specified in which the lateral shrinkage of the web is inhibited during the drying process; it is adapted to the production of a greaseproof sheet which is of uniform thickness and transparency across the width of the sheet.

2,484,749. Package. Leroy L. Salfisberg, assignor to Ivers-Lee Company, Newark, N. J. Filed Feb. 26, 1946. 3 claims. (Cl. 206-56.) A container for the packaging of medicines and the like is described.

2,484,776. Ornamental article holder. George L. Zent and Bertha M. Zent, Vancouver, Wash. Filed Jan. 6, 1948. 4 claims. (Cl. 229-8.) An ornamental bottle holder is designed to enclose and support a bottle in package form.

October 18, 1949

2,484,878. Method of preparing protein dispersions. James J. Eberl, assignor to Hercules Powder Company, Wilmington, Del. Filed March 6, 1947. 5 claims. (Cl. 106-154.) A dispersion of undenatured soybean protein in an alkali is suitable as an adhesive or, mixed with pigments, as a paper-coating composition.

2,484,938. Pressure-sensitive adhesive tape. Clarence J. Ebel and Richard G. Drew, assignors to Minnesota Mining & Manufacturing Company, St. Paul, Minn. Filed Oct. 4, 1943. 3 claims. (Cl. 260-19.) The adhesive composition consists of 300 parts bodied dehydrated castor oil, 60 parts pale wood resin, 5 parts light calcined magnesium oxide, and 30 parts Bakelite resin.

2,484,975. Shipping container. Raymond H. Van Saun, assignor to California Container Corporation, Oakland, Calif. Filed Nov. 22, 1948. 1 claim. (Cl. 229-23.) The container is reinforced at the ends and top edges so that it may be formed of relatively light material.

2,485,007. Machine for sizing tubes. Lester H. Messinger, assignor to Remington Arms Company, Inc., Bridgeport, Conn. Filed June 23, 1945. 16 claims. (Cl. 93-83.) The machine is designed to size paper tubes for shot shells; it can size smooth-surfaced and fluted tubes and can accommodate tubes of different sizes simultaneously.

2,485,040. Carton handling apparatus. William J. Cupo assignor to Waldorf Paper Products Co., St. Paul, Minn. Filed May 5, 1945. 10 claims. (Cl. 93-6.) An automatic apparatus includes means for creating from the exterior of filled cartons a differential in pressure on opposite sides of stacks of closure flaps to hold them securely while the adhesive sets.

2,485,079. Colloidal melamine-urea-formaldehyde copolymer solutions. Henry P. Wohnsiedler and Walter M. Thomas, assignors to American Cyanamid Company, New York, N. Y. Filed Jan. 4, 1944. 1 claim. (Cl. 260-29.4.) A formaldehyde condensation product containing 70 mole-% of urea and 30 mole-% of melamine forms a colloidal cationic solution which can be added to kraft or sulphite pulp in the beater; the resulting paper has good wet-strength properties.

2,485,080. Colloidal melamine-urea-formaldehyde copolymer solutions. Henry P. Wohnsiedler and Walter M. Thomas, assignors to American Cyanamid Company, New York, N. Y. Filed March 9, 1949. 1 claim. (Cl. 260-29.4.) A colloidal aqueous solution of a melamine-urea-formaldehyde copolymer which contains acetic acid as the acidifying agent is specified as a laminating agent.

2,485,083. Froth flotation of copper sulphide ores with lignin sulphonates. Robert B. Booth and Roy A. Pickens, assignors to American Cyanamid Company, New York, N. Y. Filed Jan. 4, 1946. 4 claims. (Cl. 209-166.) The surface-modifying agent may be an alkali or alkaline-earth lignosulphonate.

2,485,102. Cement composition and indurating mixture therefor. Donald R. McPherson, Wesley G. France, and Fred M. Ernsberger, assignors to The Master Builders Company, Cleveland, Ohio. Filed Nov. 29, 1945. 9 claims. (Cl. 106-90.) A hydraulic cement composition contains the dialyzed lignin residual solids retained by the dialyzing membrane in the dialysis of sulphite waste liquor which has not been concentrated or neutralized.

2,485,235. Method and apparatus for closing and sealing cartons. Paul A. Graf, assignor to Container Corporation of America, Chicago, Ill. Filed Aug. 17, 1945. 5 claims. (Cl. 93-36.8.) A method of sealing to obtain positive siftproof cartons is claimed.

2,485,248. Pressure sensitive adhesives. Frederick K. Watson and Paul Arthur, Jr., assignors to E. I. du Pont de Nemours & Company, Wilmington, Del. Filed July 14, 1945. 6 claims. (Cl. 117-122.) A greaseproof paper is coated with an ethylene-vinyl acetate copolymer; 0.05 to 0.25 parts of octadecanediol diacetate is used as a tackifier.

2,485,295. Pack of abrasive coated sheets. Adolph J. Larson, Chicago, Ill. Filed Sept. 17, 1947. 2 claims. (Cl. 206-56.) The nonabrasive surface of a paper carrier sheet carries a pressure-sensitive adhesive.

2,485,368. Pulper. George W. Dodge, assignor to The Noble & Wood Machine Company, Hoosick Falls, N. Y. Filed Jan. 9, 1947. 6 claims. (Cl. 92-20.) This is a modification of U. S. patent 1,726,874 (Sept. 3, 1929); the pulper is adapted for handling wet pulp laps, broke, waste paper, and the like.

2,485,458. Dielectric sheet and method of manufacture. Robert G. Quinn and Joseph C. Harkness, assignors to Johns-Manville Corporation, New York, N. Y. Filed March 28, 1944. 8 claims. (Cl. 92-21.) The product has an asbestos paper base which is bonded with 5–10% of its weight of a polyvinyl resin; the interstices are filled with 60–200% (based on the base paper) of a thermoplastic waterproofing agent.

October 25, 1949

2,485,597. Ethyl cellulose gels. Mortimer T. Harvey, South Orange, N. J., assignor to Harvel Research Corporation. Filed Sept. 7, 1944. 6 claims. (Cl. 106-174.) Improved gels are prepared by adding finely powdered ethylcellulose to liquid unsaturated organic materials, such as alkyl esters of abietic acid at about 140–165°; the solution thus formed changes in a gel upon cooling to 70° F. The gels can be used as a coating for paper.

2,485,704. Folded blank cup. Harold B. Cranshaw, assignor to Burnitol Manufacturing Co., Charlestown, Mass. Filed Oct. 5, 1944. 1 claim. (Cl. 229-25.) A folded paper cup (made from a single sheet) is designed for use as a sputum cup.

2,485,744. Treatment of tall oil and portions thereof. Samuel Koonce and Edmond S. Perry, assignors to Distillation Products, Inc., Rochester, N. Y. Filed Sept. 20, 1946. 3 claims. (Cl. 260-97.6.) The methyl esters of the fatty acids of tall oil are separated from the resin acids by chromatography.

2,485,816. Dispensing container. Rhodena C. Dalsemer, assignor to Siftproof Carton Associates, New York. N. Y. Filed June 7, 1944. 10 claims. (Cl. 222-566.) A container for dispensing tooth powder is described.

2,485,912. Packaging machine. Morris P. Neal, assignor to A B C Packaging Machine Corporation, Quincy, Ill. Filed Jan. 25, 1946. 19 claims. (Cl. 93-6.) The machine automatically glues, folds, and seals the top and bottom flaps of containers.

2,486,006. Apparatus for unwinding and winding web material. Everett W. Clem, assignor to Rice Barton Corporation, Worcester, Mass. Filed May 31, 1945. 8 claims. (Cl. 242-58.) The mechanism permits a roll of paper to be unwound at a given rate and rewound at a desired peripheral rate; the paper is held under a controlled positive or negative tension between the unwinding and winding zones.

2,486,037. Twisted paper thread and method of and apparatus for twisting the same. Ernest E. Lambert, assignor to Patchogue-Plymouth Mills Corporation, New York, N. Y. Filed Nov. 16, 1946. 19 claims. (Cl. 57-12.) The method permits the manufacture of variegated threads from paper ribbons of different colors; the threads are used for rugs.

2,486,045. Collapsible packaging container. James C. Madden, assignor to Consolidated Lithographing Corporation, Brooklyn, N. Y. Filed Nov. 3, 1947. 4 claims. (Cl. 229-52.) A cardboard container is shaped and constructed to resemble a lantern and is intended for bottled goods.

2,486,074. Box folding machine. Frank A. Spinale, Medford, Mass. Filed Nov. 5, 1947. 6 claims. (Cl. 93-49.) An automatic machine continuously receives and manipulates a succession of flattened tomato boxes or the like and delivers them in condition for packing.

2,486,091. Continuously forming fibrous material. Douglas D. Adams, Karl Rollius, and John B. Risher, Canton, Ohio, assignors of 76.89% to R. E. MacKenzie and 23.11% to L. V. Bockius. Filed Oct. 16, 1946. 12 claims. (Cl. 154-1.) Laminated channel structures are formed continuously from corrugated paper strips.

2,486,121. Web spreading device. William H. Corn, assignor to Ecusta Paper Corporation, New York, N. Y. Filed Jan. 24, 1947. 5 claims. (Cl. 242-75.) A spreading device is provided for avoiding wrinkles in a traveling paper web as it passes through a web-winding machine.

2,486,178. Hot food carton. Bert O. Kuehlhorn, Chicago, Ill. Filed Nov. 16, 1946. 5 claims. (Cl. 229-14.) The liner of a corrugated or fiberboard container is constructed to receive a heating element.

2,486,201. Resin for low-pressure paper base laminated and wood surfacing. Donald G. Patterson, assignor to American Cyanamid Company, New York, N. Y. Filed March 2, 1945. 1 claim. (Cl. 260-45.3.) One component consists of 55 parts of an unsaturated alkyd resin and 45 parts of styrene; the other component is a blend of 80 parts of methylated melamine-formaldehyde resin and 20 parts of styrene; 85 parts of the former and 15 parts of the latter are blended to form the laminating agent.

November 1, 1949

2,486,410. Continuous process for forming high dielectric ceramic plates. Glenn N. Howatt, Metuchen, N. J. Filed July 26, 1945. 7 claims. (Cl. 25-156.) Sulphite waste liquor is used as a binder for comminuted resin or plastic in the preparation of a ceramic slip.

2,486,419. Alkoxyl lignin halide resins and process. Raphael Katzen, assignor to Diamond Alkali Company, Cleveland, Ohio. Filed Nov. 16, 1945. 3 claims. (Cl. 260-124.) A methoxy lignin chloride is refluxed with methyl alcohol to give a transparent to translucent thermoplastic alkoxyl lignin chloride resin; the reaction is carried out in the presence of benzyl chloride and in a chlorine atmosphere.

2,486,554. Carton. Raymond Chemlinski, Schenectady, N. Y. Filed Feb. 8, 1946. 2 claims. (Cl. 120-4.) An ink bottle carton is so constructed that it can be set up as a stand for the bottle.

2,486,601. Process for producing a molding powder. Jesse M. Irwin, Dallas, Texas. Filed April 27, 1946. 5 claims. (Cl. 106-163.) Ligno-cellulosic material (40 pounds) and one pound of sulphur in 80 pounds of water are heated 5 minutes at 198° C./150–200 p.s.i., and then 20 minutes at 160–2000 p.s.i., and the product is molded at 300° F. and 4000 p.s.i., or at 388° F. and 800 p.s.i.

2,486,703. Pin control for web folding machines. Nathaniel Bishop, assignor to Time, Inc., New York, N. Y. Filed March 13, 1947. 9 claims. (Cl. 270-71.) A folded pin control apparatus for web folding machines operates effectively at relatively high speeds.

2,486,745. Foldable cabinet. Walter K. Harris, Richmond, Va. Filed March 25, 1946. 4 claims. (Cl. 229-41.) A cardboard cabinet is described.

2,486,974. Recovery of stearic and abietic acid from hydrogenated tall oil. Donald F. Othmer, Coudersport, Pa., and George Papps, New York, N. Y. Filed Aug. 11, 1944. 8 claims. (Cl. 260-97.6.) Stearic acid and abietic acid in hydrogenated tall oil are separated by adsorption onto an activated carbon adsorbent and elution with an organic solvent.

2,487,000. Process of separating the constituents of tall oil and similar mixtures. George E. Taylor, Joe S. Metcalf, and Lewis L. Branscomb, assignors to Monsanto Chemical Company, St. Louis, Mo. Filed Dec. 3, 1945. 31 claims. (Cl. 260-97.6.) A crystalline abietic acid from tall oil is treated at 280–290° C. with steam at the rate of 5 grams per minute for 80 minutes and further heated at this temperature for 3 hours in a carbon dioxide atmosphere. The product is suitable for paper size, adhesive tape, and the like.

November 8, 1949

2,487,060. Barrier coat for adhesive sheets. Charles O. Pike and Vlon N. Morris, assignors to Industrial Tape Corporation, New Brunswick, N. J. Filed Nov. 20, 1946. 5 claims. (Cl. 117-76.) A synthetic rubber barrier is used between the adhesive layer and the porous backing (e.g., paper); formulas are given for the barrier.

2,487,100. Drinking cup of sheet material. Meyer Cohen, Flushing, N. Y. Filed Aug. 19, 1947. 5 claims. (Cl. 229-7.) A paper cup has a drinking straw incorporated in the body of the cup.

2,487,114. Process for producing acetylatable cellulose from straw. Henry Dreyfus, assignor to Celanese Corporation of America, New York, N. Y. Filed Oct. 3, 1945. 6 claims. (Cl. 92-13.) Straw is pretreated with dilute sodium hydroxide at 100–125° C., disintegrated, and treated in two stages at 50–60° C. with an aqueous solution containing 10–20% hydrogen peroxide and 7–20% sodium hydroxide.

2,487,123. Combination packing and display device. Felix F. Fluss, New York, N. Y., and George Jellinek, Plainfield, N. J. Filed May 21, 1946. 7 claims. (Cl. 206-65.) A corrugated board packing and display device is adapted to hold bulky or elongated articles.

2,487,202. Suction box cover. George R. Wadleigh, assignor of one half to West Virginia Pulp and Paper Company, New York, N. Y. Filed Aug. 7, 1943. 1 claim. (Cl. 92-51.) The cover has perforations which are inclined from the top to the bottom in the direction of the wire travel. The water leaving the wire or felt is prevented from splashing and less vacuum is required.

2,487,293. Multicompartment container. Jack R. Belsinger, assignor to Belsinger, Inc., Atlanta, Ga. Filed June 17, 1947. 7 claims. (Cl. 229-15.) A container has several inner members which can be individually filled with different commodities and delivered to an assembly point, where they are combined with outer members.

2,487,409. Doctor blade and mounting. Herbert A. Baker, assignor to Vickerys Limited, London, England. Filed Dec. 21, 1945. 2 claims. (Cl. 92-74.) A doctor blade is so constructed that the blade can conform with variations in the surface of the roll.

2,487,448. Polyvinyl alcohol-starch-clay adhesives, processes, and products. Richard W. Kingerley, Jr., assignor to E. I. du Pont de Nemours & Company, Wilmington, Del. Filed March 1, 1944. 20 claims. (Cl. 154-138.) An adhesive for water-resistant laminated board consists of swollen starch, polyvinyl alcohol, and a nonalkaline clay; formulas are given.

2,487,491. Bottle carrier. George F. Stone, assignor to The Canister Company, Inc., Phillipsburg, N. J. Filed Dec. 28, 1945. 2 claims. (Cl. 229-52.) The side and end walls are formed of board and the bottom is formed of sheet metal.

2,487,519. Lid for jars, bottles, and like containers. John C. Brow, Belfast, Northern Ireland. Filed Sept. 24, 1945. 2 claims. (Cl. 215-38.) The lid is formed of cardboard which is sheathed with parchment paper.

2,487,528. Die-cut insert for gun packing cases. Kenwood S. Dawson, assignor to Waterbury Corrugated Container Co., Waterbury, Conn. Filed July 15, 1948. 10 claims. (Cl. 206-46.) Corrugated cushion members are used for protecting a completely assembled gun during shipment.

2,487,643. Paper bag construction. Blanche Frischer, Bronx, N. Y. Filed Aug. 14, 1948. 8 claims. (Cl. 229-68.) A shipping bag is equipped with cardboard-reinforced handles.

2,487,647. Heating system for corrugating machines. Walter J. Goettsch, assignor to Samuel M. Langston Co., Camden, N. J. Filed Nov. 27, 1945. 14 claims. (Cl. 154-32.) In the manufacture of double-faced corrugated paper, it is passed over a series of plates which are heated with steam; means are provided for separating the condensate from the noncondensable gases and for moistening and heating the sheet as delivered to the double-facer.

2,487,702. Motor drive for papermaking machines. John E. Goodwillie and Edward D. Beachler, assignors to Beloit Iron Works, Beloit, Wis. Filed March 2, 1946. 9 claims. (Cl. 192-.02.) A control arrangement is adapted to govern the operation of a clutch which effects the coupling of two independently rotating mechanisms.

2,487,755. Strip material loop control. William Few, assignor to The Clark Controller Company, Cleveland, Ohio. Filed Sept. 11, 1947. 18 claims. (Cl. 318-6.) A motor is provided for maintaining a loop in a web of material between the supply source and the feeding mechanism.

November 15, 1949

2,487,899. Process of wax sizing papermaking fibers using a cationic surface active agent. Laurence R. Sherman, assignor to Nopco Chemical Company, Harrison, N. J. Filed May 10, 1945. 4 claims. (Cl. 92–21.) Wax is added to fibers in water heated above the melting point of the wax and a cationic compound is added to fix the wax to the fibers.

2,487,908. Apparatus for determining the strength of paper and other foliaceous material. Arnoldus J. J. M. van der Korput, Baarn, Netherlands. Filed Oct. 2, 1946. 6 claims. (Cl. 73-98.) An apparatus is described for determining the tensile strength of paper.

2,488,034. Flame resistant materials. Raymond A. Pingree and Raymond C. Ackerman, assignors to Sun Chemical Corporation, New York, N. Y. Filed Nov. 18, 1943. 1 claim. (Cl. 117-136.) The flameproofing agent consists of the reaction product of guanylurea phosphate and formaldehyde.

2,488,038. Method of forming valve bags. William E. Sharkey, assignor to The Raymond Bag Company, Middletown, Ohio. Filed Aug. 23, 1946. 11 claims. (Cl. 93-35.) A valve sleeve for cement bags can be inserted mechanically during their manufacture.

2,488,041. Hydraulic debarking method. Frank H. Swift, assignor to Crown Zellerbach Corporation, San Francisco, Calif. Filed Oct. 3, 1946. 3 claims. (Cl. 144-309.) Hydraulic debarking nozzles can be used for cants and slabs, as well as whole logs.

2,488,121. Folding box. Herman L. Greve, Hollis, N. Y. Filed Oct. 1, 1946. 2 claims. (Cl. 229-33.) A board cigar box has a simulated wood cover and a metal-foil moisture-retaining liner.

2,488,186. Process for preparing phenolic material from a lignin substance. Donald H. Grangaard, assignor to Sulphite Products Corporation, Appleton, Wis. Filed Aug. 8, 1947. 15 claims. (Cl. 260-621.) Catechol is obtained from lignin-containing material by heating at 200–300° with an amine salt, such as aniline, tributylamine, or dimethylamine hydrochloride.

2,488,194. Container. Melvin T. Hunsworth, assignor to Container Corporation of America, Chicago, Ill. Filed July 22, 1946. 11 claims. (Cl. 229-23.) A paperboard container is rigid and nonweaving; integral means for anchoring an opening rip cord in the container are provided.

2,488,294. Wire guide. Lloyd Hornbostel, assignor to Beloit Iron Works, Beloit, Wis. Filed May 29, 1947. 10 claims. (Cl. 74-241.) The movements of a light weight feeler member are greatly amplified in force by a multistage fluid-pressure control mechanism in order to shift a moveable bearing on the wire- or felt-supporting roll in the proper direction and amount to return the wire or felt to a predetermined neutral axial position on the roll.

2,488,323. Dispensing carton. Henry C. Parker, Washington, D. C. Filed April 18, 1946. 7 claims. (Cl. 229-17.) The carton has a top formed of flaps sealed one above the other; an outer flap comprises a pouring spout blank.

2,488,385. Sizing compositions. Arthur C. Dreshfield, assignor to Hercules Powder Company, Wilmington, Del. Filed March 23, 1945. 13 claims. (Cl. 106-230.) A dry saponified rosin size is stabilized with a secondary organic amine and 15–25% of a wax.

2,488,515. Utilization of waste wax paper. Laurence R. Sherman and W. Ronald Benson, assignors of one half of Nopco Chemical Company and one half to Crown Zellerbach Corporation, San Francisco, Calif. Filed May 10, 1945. 6 claims. (Cl. 92-21.) Wax paper broke is disintegrated in hot water and the mixture is treated with a cationic compound to fix the wax on the fibers.

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2,488,685. Spot cementing apparatus for laminating machines. Walter S. Riddle, assignor to Seaman Paper Company, Chicago, Ill. Filed June 2, 1945. 2 claims. (Cl. 91–47.) A machine is adapted to the application of spots of adhesive in transverse rows across the surface of a strip and to bring it into engagement with another strip to form a multiply strip.

2,488,700. Apparatus for paper manufacture. George L. Bidwell, assignor to Riegel Paper Corporation, New York, N. Y. Filed May 17, 1945. 2 claims. (Cl. 92-44.) A machine for

producing imitation handmade paper has a short endless wire screen which travels upwardly at an angle of about 15° between a pond of diluted stock and the suction box; the screen passes over rolls which are arranged in triangular relation.

2,488,703. Collapsible tray or carton. Kenneth T. Buttery, assignor to Sutherland Paper Company, Kalamazoo, Mich. Filed Dec. 29, 1945. 14 claims. (Cl. 229-35.) The end walls and corner flaps are wider than the side walls and support a transparent wrapper so that the goods are visible.

2,488,704. Collapsible tray or carton. Kenneth T. Buttery, assignor to Sutherland Paper Company, Kalamazoo, Mich. Filed April 9, 1948. 10 claims. (Cl. 229-35.) This is a modification of the above patent; it is claimed that hand and machine erection are facilitated.

2,488,705. Collapsible tray or box and box member. Kenneth T. Buttery and Richard C. Stenger, assignors to Sutherland Paper Company, Kalamazoo, Mich. Filed Sept. 10, 1948. 6 claims. (Cl. 229-35.) The box is formed from an integral blank with interlocking walls which are supported against bulging and collapsing stresses.

2,488,706. Collapsible tray or box. Kenneth T. Buttery and Richard C. Stenger, assignors to Sutherland Paper Company, Kalamazoo, Mich. Filed Sept. 10, 1948. 7 claims. (Cl. 229-35.) A box formed of an integral blank may be shipped flat and set up manually or by machine.

2,488,722. Catalytic hydrogenation of cellulose to produce oxygenated compounds. Hamit H. Gürkan, Ankara, Turkey. Filed Nov. 14, 1946. 8 claims. (Cl. 260-594.) Cellulose in Schweizer reagent is hydrogenated at 140–190° C. under pressure for about two hours and the coprecipitate of cellulose and metallic copper is hydrogenated at 240–332° C. under a pressure of 700 p.s.i. in the presence of water and hydrogen for about five hours to give alcohols, glycols, and hydroxyketones.

2,489,034. Combined box handle and partition. Louise James, assignor to Huye Space Saving Box System, Inc., New Orleans, La. Filed July 8, 1946. 4 claims. (Cl. 229-15.) The sheet material of the handle is reinforced by folding in such a manner that a multiply structure is attained at the areas of greatest stress.

2,489,054. Pallet. Joseph V. Sprolle, assignor to The National Sugar Refining Company, New York, N. Y. Filed Sept. 7, 1946. 4 claims. (Cl. 206-46.) A method of using pallets is described.

2,489,079. Apparatus for forming fibrous sheets or paperboard. James d'A. Clark and Sidney D. Wells, assignors to The Institute of Paper Chemistry, Appleton, Wis. Filed April 18, 1946. 8 claims. (Cl. 154-29.) An airborne mixture of fibers and fine particles of a thermosetting adhesive is deposited on a moving screen and consolidated with heat and pressure.

2,489,145. Synthetic resin compositions employing curing catalysts. David J. Lieb, Laurence E. Clark, Jr., and Raymond J. Spahr, assignors to The Borden Company, New York, N. Y. Filed Jan. 18, 1947. 1 claim. (Cl. 260-71.) Sheets of paper coated with an organo-boron trihalide complex and an acid-curing resin are resistant to moisture, insects, and fungi.

2,489,170. Adhesive composition for paper. Leonard C. Wooster and Earl E. Gardiner, assignors to Stancal Asphalt & Bitumuls Company, San Francisco, Calif. Filed March 7, 1944. 16 claims. (Cl. 154-45.9.) An aldehyde for forming multiply board consists of 17% acid dextrin starch, 45% water, 1.7% water-soluble urea-formaldehyde resin, 0.2% ammonium chloride, and 36.1% asphalt emulsion.

2,489,200. Separation of vanillin from alkaline solutions. Charles A. Sankey and Harry B. Marshall, assignors to The Ontario Paper Company Limited, Thorold, Ontario, Canada. Filed Sept. 28, 1946. 1 claim. (Cl. 260-600.) Vanillin is separated in the form of its sodium salt from an aqueous alkaline solution by extraction with tertiary-butyl alcohol.

2,489,210. Apparatus for adhesively uniting sheet materials. Norman E. Weeks, assignor to Bemis Bro. Bag Company, St. Louis, Mo. Filed Dec. 7, 1946. 10 claims. (Cl. 154-1.6.) Paper valve sleeves in bag valves are adhesively united by means of a thermoplastic adhesive.

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2,489,271. Foldable decoy. William G. Colgan, Oakland, Calif. Filed Oct. 18, 1946. 8 claims. (Cl. 43-3.) A decoy made from a foldable blank is provided with sides and breast flaps extending across the front of the sides to hold the latter a predetermined distance apart.

2,489,380. 5-Hydroxymercurivanillin and methods of making the same. Harry F. Lewis and Irwin A. Pearl, assignors to Sulphite Products Corporation, Appleton, Wis. Filed July 18, 1945. 4 claims. (Cl. 260-434.) Lignin is oxidized with mercuric oxide and sodium hydroxide; uses of the vanillin derivative are outlined.

2,489,507. Paper cup machine. Arthur Shapiro and Malcolm Hirschey, assignors to Eagle Cone Corporation, Brooklyn, N. Y. Filed Nov. 21, 1947. 10 claims. (Cl. 93-60.)

2,489,528. Paperboard or the like receptacle partition. Harry H. Goldstein, North Arlington, Va. Filed Nov. 17, 1948. 5 claims. (Cl. 217-31.) A board partition structure is used with portable boxes to form individual cells or compartments.

2,489,541. Molding material. Harold E. Read, assignor to Continental Can Company, Incorporated, New York, N. Y., Filed Jan. 3, 1946. 3 claims. (Cl. 154-46.) A laminated molding material comprises a fibrous sheet having a plurality of slits and stretched so as to have a flexible open-mesh structure; the surface sheets are impregnated with a phenol-formaldehyde resin.

2,489,572. Process for the production of perchlorates and chlorine dioxide. Clifford A. Hampel, assignor to Cardox Corporation, Chicago, Ill. Filed Feb. 13, 1946. 19 claims. (Cl. 23-85.) A mixture of 3 moles of sodium chlorate and 0.5 mole of potassium sulphate is treated with 85% sulphuric acid at 20–65° C. The isolation of chlorine dioxide and potassium perchlorate is described.

2,489,574. Process for the production of perchlorates and chlorine dioxide. Clifford A. Hampel, assignor to Cardox Corporation, Chicago, Ill. Filed April 2, 1946. 7 claims. (Cl. 23-85.) A perchlorate and chlorine dioxide are produced by the reaction of sulphuric acid and a metallic chlorate.

2,489,616. Container. Kenneth T. Buttery, assignor to Sutherland Paper Company, Kalamazoo, Mich. Filed Aug. 2, 1946. 6 claims. (Cl. 229-5.5.) In a carton for packaging and freezing fruits, a depressor member in the lid serves to hold the fruit submerged in the packing sirup.

2,489,726. Packaged food product and packing method. George F. Salerno, Wilmette, Ill. Filed Oct. 19, 1948. 4 claims. (Cl. 99-171.) A package for soda crackers consists of an outer semirigid container and an inner preformed moisture-proof bag.

2,489,817. Sealing means for cartons. Manuel G. Rodriguez, New York, N. Y. Filed April 17, 1947. 12 claims. (Cl. 229-29.) A sealing tape or string is inserted through the vertical partitions of a cellular egg carton to secure them to the body of the carton.

2,489,922. Composite wall panel. Carl G. Muench, assignor to The Celotex Corporation, Chicago, Ill. Filed June 30, 1944. 3 claims. (Cl. 154-44.) A wall structure comprises a body of insulating material and an interior finishing layer of hardened plastic building material.

December 6, 1949

2,490,057. Method of making an infusion package with a nontangling handle and tag. Hans O. Irmscher, assignor to National Urn Bag Co., Inc., Long Island City, N. Y. Filed May 25, 1946. 4 claims. (Cl. 93-2.) A tea or coffee bag is provided with pressure heat-sealed joint seams.

2,490,078. Manufacture of plastic products from wood (sulphur cook process). John G. Meiler, assignor to Diamond Alkali Company, Cleveland, Ohio. Filed April 12, 1946. 12 claims. (Cl. 106-123.) Lignocellulose is digested with kraft black liquor containing 3–6% elemental sulphur at 150–250° C.; the product is suitable as a moldable composition.

2,490,133. Carton. William H. Inman, assignor to Bloomer Bros. Company, Newark, N. Y. Filed Aug. 25, 1945. 8 claims. (Cl. 229-51.) A carton blank has a plurality of lines of scoring and gives a carton from which sections can be removed to expose successive zones of the contents.

2,490,157. Decorticating machine. John S. Reeves, Baltimore, Md. Filed April 9, 1946. 10 claims. (Cl. 19-15.) The machine is suitable for fibers such as sansevieria, henequen, and the like.

2,490,165. Log debarking machine. Ernest C. Shaw, assignor to Allis-Chalmers Manufacturing Company, Milwaukee, Wis. Filed April 17, 1944. 3 claims. (Cl. 144-208.) A hydraulic debarker is provided with log-transferring, debarking, and cleaning mechanism; see U. S. patent 2,338,136 (Jan. 4, 1944).

2,490,186. Bicycle package. Paul J. Yarman, assignor to The Ohio Boxboard Company, Rittman, Ohio. Filed May 28, 1947. 4 claims. (Cl. 206-46.) Corrugated board spacing and blocking members are provided for a bicycle shipping carton.

2,490,271. Sulphurized nitriles and process of preparing the same. Samuel E. Jolly, assignor to Sun Oil Company, Philadelphia, Pa. Filed June 25, 1943. 3 claims. (Cl. 260-97.5). Oil-soluble suphurized nitriles are prepared from the nitriles of tall oil by reaction with sulphur at a temperature above 190° C. but below their decomposition points. They are useful in lubricants, cutting oils, and greases.

2,490,299. Carton molding apparatus. Russell J. Hennessey, assignor to Waldorf Paper Products Company, St. Paul, Minn. Filed Nov. 1, 1943. 12 claims. (Cl. 18-1.) A carton-sealing mechanism is adapted for molding siftproof carton corners.

2,490,326. Egg crate flat. Louis Schwartzberg, Chicago, Ill. Filed Dec. 2, 1948. 3 claims. (Cl. 217-26.) A pulp flat for an egg crate carries a number of rosettes, each formed with three

protuberances equally spaced about a common center on opposite sides of the sheet forming a flat.

2,490,430. Composition roofing. Harold W. Greider and George A. Fasold, assignors to The Philip Carey Manufacturing Company, Lockland, Ohio. Filed Aug. 7, 1943. 14 claims. (Cl. 117-30.) A roof covering consists of sheet-like base material and a plurality of layers of thermoplastic bituminous composition.

2,490,533. Digester control. James M. McAlear, assignor to Mason-Neilan Regulator Company, Boston, Mass. Filed April 25, 1947. 15 claims. (Cl. 183-61.) A gasoff and strainer-cleanout control mechanism incorporates pressure- and temperature-responsive elements of a differential controller which actuate a valve in the digester-relief line to bleed gases as required to maintain the desired temperature.

2,490,550. Moistureproof heat-sealing composition. John P. Sermattei, assignor to E. I. du Pont de Nemours & Company, Wilmington, Del. Filed Aug. 13, 1947. 15 claims. (Cl. 260-28.5.) A glassine paper is rendered heat sealable and moistureproof by an adherent film of the composition: 12.2% ethylene-vinyl acetate copolymer, 19.3% phenol-formaldehyde modified rosin, 3.5% paraffin, and 65% of a suitable solvent (e.g., toluene).

2,490,557. Box. Jerome Stone, Chicago, Ill. Filed Nov. 17, 1944. 10 claims. (Cl. 229-52.) A cardboard garment box with a handle.

2,490,685. Mount for web rolls. Robert H. Greene, Marion, Ind. Filed Nov. 8, 1946. 6 claims. (Cl. 242-58.) A mount for web rolls is adapted for elevating and supporting heavy rolls in selected positions to be unwound.

2,490,697. Folding apparatus. Freeman M. McBeth, Harrisburg, Pa., assignor to Macbeth Engineering Corporation. Filed April 28, 1945. 2 claims. (Cl. 93-2.) A mechanism is adapted for folding and closing the open ends of paper bags or cartons.

2,490,732. Dispensing package. Joseph J. Hess and Edward E. Thatcher, assignors to E. C. Atkins and Company, Indianapolis, Ind. Filed June 27, 1946. 4 claims. (Cl. 206-16.) A container has an octagonal compartment to receive a coil of band-saw blade.

2,490,750. Method of removing scale. Fredrik W. Grewin and Sten G. Lindberg, assignors to Rosenblad Corporation, New York, N. Y. Filed Sept. 15, 1942. 5 claims. (Cl. 159-47.) In concentrating sulphite waste liquor in a multiple-effect evaporator, the paths of the heating medium and the heated liquor are interchanged at intervals.

2,490,754. Activation of cellulose for acylation. William B. Hincke and George A. Richter, assignors to Eastman Kodak Company, Rochester, N. Y. Filed Aug. 4, 1945. 3 claims. (Cl. 260-212.) A cellulose sheet with 35 to 65% moisture is stored at 100–180° F. and 80–100% relative humidity for 1 to 14 days and subsequently dewatered with butyric acid.

2,490,759. Method of cleaning scale. Arnold E. Tydén, assignor to Rosenblad Corporation, New York, N. Y. Filed Oct. 6, 1943. 3 claims. (Cl. 159-23.) The hot scale-removing fluid and the heated sulphite waste liquor are caused to change paths with each other at intervals in the heat exchanger.

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2,490,930. Method and apparatus for forming tubes from sheet materials. Donald C. Thompson, assignor to American Viscose Corporation, Wilmington, Del. Filed Aug. 28, 1946. 8 claims. (Cl. 93-20.) Tubes are formed from paper by overlapping the edges of a continuous sheet while introducing an adhesive substance between the edges, pressing the edges together, and passing the tube in an upwardly inclined path.

2,490,940. Method of and means for forming and filling bags. William J. Barker, Fort Worth, Texas. Filed Feb. 11, 1946. 14 claims. (Cl. 226-50.) A method is described for successively forming reinforced paper bags from a continuous length of preformed tubular material.

2,490,966. Valve bag. John Johnsson, assignor to Billeruds Aktiebolag, Saffle, Sweden. Filed March 20, 1946. 4 claims. (Cl. 229-62.5.) A multiply paper bag with a filling valve is improved by providing the top wall of the tube with a bendable stiffening insert of metal which retains the tube in the folded position.

2,491,030. Skid loader. John L. Budreau, assignor to Minnesota and Ontario Paper Company, Minneapolis, Minn. Filed Nov. 28, 1947. 3 claims. (Cl. 214-131.) A skid loader for handling logs is provided with pivotally mounted arms.

2,491,039. Carrier for bottles or like articles. Vincent Fortunato, assignor to Morris Paper Mills, Chicago, Ill. Filed March 20, 1943. 10 claims. (Cl. 224-45.) A cardboard bottle carrier is cut from a single rectangular blank.

2,491,067. Removable log bunk. John E. Whalley, Eugene, Oregon. Filed July 17, 1945. 3 claims. (Cl. 105-160.) A log bunk is described which can be quickly mounted on and removed from a standard flatcar or truck, so that the vehicle can be used for logging or general service.

2,491,069. Snatch block. Edward J. Anderson, Eino Lehto, and Matt Saari, assignors to Marathon Corporation, Rothschild, Wis. Filed May 12, 1947. 2 claims. (Cl. 254-194.) A snatch block is constructed of high tensile-strength steel.

2,491,090. Printing plate. William W. Davidson, assignor to Davidson Manufacturing Corporation, Chicago, Ill. Filed March 1, 1946. 13 claims. (Cl. 101-149.2.) A planographic printing plate is formed of a paper-base plastic.

2,491,113. Water-borne aluminum coatings on paper. Stanley J. Johnson, assignor to S. D. Warren Company, Boston, Mass. Filed Jan. 14, 1946. 3 claims. (Cl. 260-6.) A paper-coating composition comprises finely divided aluminum, casein, urea, sodium pyrophosphate, and 5–20% dimethylolurea (based on the dry weight of the casein).

2,491,149. Bottle carrier. Edwin L. Arneson, assignor to Morris Paper Mills, Chicago, Ill. Filed Aug. 14, 1946. 4 claims. (Cl. 224-45.) A glued paperboard or cardboard bottle carrier is provided with a handle which can be bent to permit vertical stacking of the filler carriers.

2,491,206. Collapsible shipping case. Roy C. Potts, Takoma Park, Md. Filed April 26, 1944. 16 claims. (Cl. 229-23.) A multicompartment corrugated or solid fiberboard (45–80 points) shipping case is provided with supports for its top and bottom closure flaps.

2,491,213. Tube closure. Joseph J. Robinson, Jr., assignor to Marsh Wall Products, Inc., Dover, Ohio. Filed Nov. 15, 1946. 7 claims. (Cl. 229-47.) A sheet metal plug or bung is provided which requires no nails or other separate fastening means for securing it within a cardboard shipping or mailing tube.

2,491,227. Greeting card and envelope assembly. Aaron Sugar, Philadelphia, Pa. Filed Feb. 20, 1947. 2 claims. (Cl. 229-68.) A combined greeting card and envelope assembly incorporates a price-marking tab on the envelope.

2,491,278. Seal-end carton. William A. Ringler, assignor to The Gardner Board and Carton Co., Middletown, Ohio. Filed April 17, 1946. 3 claims. (Cl. 229-38.) The interior or first-folded flaps do not curl or warp under considerable resilient pressure.

2,491,436. Drilling mud. William E. Barnes, assignor to Sun Oil Company, Philadelphia, Pa. Filed July 11, 1947. 17 claims. (Cl. 252-8.5.) An aqueous drilling mud comprises calcium bentonite dissolved in water and 1–10 pounds per barrel of calcium lignosulphonate as a viscosity-reducing material.

2,491,437. Drilling mud. Holloway W. Perkins, assignor to Sun Oil Company, Philadelphia, Pa. Filed Aug. 3, 1948. 6 claims. (Cl. 252-8.5.) An aqueous drilling mud consists of calcium bentonite, 1–10 pounds per barrel of calcium lignosulphonate, and 0.75–3 pounds of quebracho per barrel.

December 20, 1949

2,491,499. Treating ligno-cellulosic materials and resulting product. Raphael Katzen and Joseph Pearlstein, assignors to Diamond Alkali Company, Cleveland, Ohio. Filed Feb. 12, 1946. 10 claims. (Cl. 260-124.) Maple sawdust in boiling dioxane is treated one hour with chlorine and the filtrate is evaporated and precipitated into water, giving an ethoxylignin chloride.

2,491,554. Tray. Alan W. Finley, McKees Rocks, Pa. Filed Oct. 1, 1946. 3 claims. (Cl. 229-30.) An advertising table piece embodies an ash tray and a vertical center member.

2,491,663. Package. Oscar H. Hultin, assignor to Pneumatic Scale Corporation, Limited, Quincy, Mass. Filed Jan. 29, 1946. 6 claims. (Cl. 228-37.) A carton is constructed to contain bird seed and in an end compartment a bird biscuit.

2,491,680. Container. Carl E. Meyerhoefer, assignor to Lewyt Corporation, Brooklyn, N. Y. Filed March 15, 1947. 5 claims. (Cl. 206-16.) A corrugated board container is designed to house a vacuum cleaner and its accessories.

2,491,689. Moisture tester. Jacob Pollack, assignor to General Fibre Products Co., Maspeth, N. Y. Filed May 9, 1945. 16 claims. (Cl. 175-183.) The moisture permeability is determined by measuring the decrease in resistance of the paper as a liquid electrolyte is passed through the specimen.

2,491,832. Lignin dispersing agents and method of making same. Jorgen R. Salvesen, Carlyle Harmon, and William C. Browning, assignors to Marathon Corporation, Rothschild, Wis. Filed Sept. 23, 1946. 9 claims. (Cl. 260-124.) A partially desulphonated lignosulphonate dispersing agent is produced by heating sulphite waste liquor and caustic under pressure at 140–170° C., continuously introducing air into the liquor until the pH is 10.5–11, filtering, acidifying, washing the precipitate, dissolving in caustic soda at pH 5–9, and drying.

2,491,929. Carrier bag. Herman C. Orchard, assignor to Orchard Paper Company, St. Louis, Mo. Filed April 27, 1946. 3 claims. (Cl. 229-68.) A paper shopping bag is provided with a flexible cord handle.

2,492,026. Phonograph record album. Preston L. Andrews, Floral Park, N. Y. Filed Feb. 26, 1947. 2 claims. (Cl. 129-

20.) Paper phonograph record envelopes are so constructed as to provide an open hinging fold or loop portion at the edge which is to be anchored in an album.

2,492,047. Bleaching wood pulp. Paul B. K'Burg and Joseph S. Reichert, assignors to E. I. du Pont de Nemours & Company, Wilmington, Del. Filed March 30, 1946. 3 claims. (Cl. 8-104.) Mechanical pulp is passed through a mist-like dispersion of an alkaline aqueous peroxide solution in air in an enclosed space.

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2,492,321. Apparatus for stripping bark from step-by-step advanced sawmill edgings or slabs. John R. Roberts, De Valls Bluff, Ark. Filed Sept. 18, 1947. 14 claims. (Cl. 144-208.) Means are provided for the automatic advance of a slab which is to be barked.

2,492,454. Folding paper box. Wilbur G. Anderson, Jr., assignor to American Box Board Company, Grand Rapids, Mich. Filed Nov. 17, 1947. 5 claims. (Cl. 229-36.) A folding paper box is designed for the shipment of dressed poultry.

2,492,500. Metal end closure for waxed paper container bodies. Clayton W. Priest, assignor to Continental Can Company, Inc., New York, N. Y. Filed April 14, 1947. 7 claims. (Cl. 229-5.5.) The metal end closure for a tubular body of paper or equivalent material is formed to include an annular channel defined in part by a heel wall and a skirt between which the end of the body is tightly clamped.

2,492,567. Wrapping machinery. Joseph A. Gilbert, assignor to Rose Brothers (Gainsborough) Limited, Gainsborough, England. Filed Oct. 4, 1946. 14 claims. (Cl. 93-2.) A machine for wrapping rectangular articles with paper, foil, film, or other material.

2,492,599. Disposable bib. Helen E. Smith, New York, N. Y. Filed April 25, 1946. 2 claims. (Cl. 2-49.) A disposable paper bib consists of three sheets crimped together to form a unit.

2,492,702. Process of sizing paper and product. Willi Neubert, Hans Krzikalla, and Richard Armbruster, assignors to General Aniline & Film Corporation, New York, N. Y. Filed June 16, 1939. 6 claims. (Cl. 92-21.) Saponified rosin (0.5%) is added to the beater and precipitated with 2% alum and 0.5% of a condensation product of one mole of ammonium chloride, two to three moles of formaldehyde, and one mole of acetaldehyde. Before or after sizing, 0.1% of a naphthalenesulphonic acid-formaldehyde condensation product can be added.

2,492,712. Tubular carton with strong end closures. William A. Ringler, assignor to Gardner Board and Carton Co., Middletown, Ohio. Filed July 3, 1946. 4 claims. (Cl. 229-39.) A mailing carton is provided with a closure which is not subject to accidental opening.

2,492,713. Guide for paper rolling machines. Leo Roy, Troy, N. Y. Filed Feb. 8, 1946. 2 claims. (Cl. 242-65.) A guide mechanism serves to prevent coning of a paper roll during the winding operation.

2,492,760. Decorative protective coating composition. Clyde G. Murphy and John P. Sermattei, assignors to E. I. du Pont de Nemours & Company, Wilmington, Del. Filed Aug. 13, 1947. 7 claims. (Cl. 260-27.) A glossy flexible coating for paper and board is obtained by plasticizing certain hard brittle resins (coumarone-indene resins, phenol-formaldehyde modified rosins, or pentaerythritol-modified rosin) with rubbery-type synthetic resins (ethylene-vinyl acetate copolymer).

2,492,821. Permanent paper and method of making same. John Studeny, John D. Pollard, and Chester G. Landes, assignors to American Cyanamid Company, New York, N. Y. Filed Sept. 28, 1948. 5 claims. (Cl. 117-152.) The stability of a paper against aging is improved by impregnating the paper with an aqueous solution of sodium, potassium, or ammonium dicyanamide and drying so that the paper retains 0.3 to 10% of the compound.

2,492,822. Permanent paper and method of making same. John Studeny, John D. Pollard, and Chester G. Landes, assignors to American Cyanamid Company, New York, N. Y. Filed Sept. 28, 1948. 5 claims. (Cl. 117-152.) The paper is impregnated with ammonium or an alkali salt of dicyanoguanidine and dried so that it retains 0.3 to 10% of the chemical.

2,492,886. Method of and apparatus for forming paper end closures. William F. Punte, assignor to Continental Can Company, Inc., New York, N. Y. Filed June 30, 1944. 15 claims. (Cl. 93-36.) A paper end closure includes a body portion which is adapted to fit into the end of a container, an annular wall at right angles to the body, and a skirt spaced from the wall to form a peripheral groove which will accept the end of the container wall.

TAPPI TESTING DIVISION CONFERENCE

Rochester, N. Y. September 13–15, 1950

RECENT BOOKS

Paper Year Book—1950. Edited by Anita Reinig, Davidson Publishing Co., 407 Superior St., Duluth 2, Minn. Cloth, $8^1/_2 \times 11^1/_2$, 584 pages, $10.

This eighth annual edition of the encyclopedia of paper represents a complete revision with the addition of many new products, new charts, and tables. More than 1000 papers, paper products, and related items are described and illustrated with over 700 photographs and 100 charts and tables. The markets for the various papers are indicated. The principal section headings are coarse paper, fine and printing papers, wrapping papers, testing methods, and paper making and paper markets.

Specialty Papers. Edited by Robert H. Mosher, formerly of The Marvellum Co., and the Holyoke Card & Paper Co. Chemical Publishing Co. and Remsen Press. 1950. Cloth, $5^1/_2 \times 8^1/_2$, 520 pages. Illustrated. $10.

The authorship of this interesting and useful book includes the names of so many TAPPI members that it might very well have been one or more of the series of TAPPI Monographs. Included among the contributors are such individuals as Wm. H. Aiken, of Goodyear Tire & Rubber Co., Robert S. Aires, Polytechnic Institute of Brooklyn, Robert B. Blakeslee, Imperial Paper & Color Corp., Rufus Blount, Hampden Glazed Paper and Card Co., Martin L. Downs, Thilmany Pulp & Paper Co., F. W. Farrell, McLaurin-Jones Co., George Schmid, the Cellutin Co., R. H. Simmons, Government Printing Office, and Arthur M. Worthington, American Tissue Mills, all TAPPI members.

The purpose of the book is to compile the information available on the different products of the specialty paper converting industry, on the raw material which goes into them, on the techniques of their manufacture, and on the tests used in their evaluation.

It is apparently the first book printed in the English language devoted exclusively to specialty papers. Among the subjects covered are gift wraps, decorative papers, functional and protective papers, high-gloss specialty papers, cover papers, asphalt and waterproof papers, waxed papers, gummed papers, carbon papers, fibrous, and metal foil papers.

A Chemistry of Plastics and High Polymers. By P. D. Ritchie, Head, Dept. of Chemistry, Central Technical College, Birmingham, England. Interscience Publishers, Inc. New York. Cloth. $5^1/_2 \times 8^1/_2$, 288 pages. $4.50.

This book is based on lectures given by the author at Leeds College of Technology and was prepared as a compact summary of the subject of high polymers, especially the organic chemistry related thereto. Throughout the book it is assumed that the readers knowledge of chemistry is at the graduate level. Among the subjects treated are mechanism and kinetics of polymerization, synthetic addition high polymers, synthetic condensation high polymers, high polymers in nature, the protein, cellulose, lignin, and rubber groups, the drying oils, mineral and inorganic high polymers, the relation between the structure and physical properties of high polymers. A good index is appended.

Copies of all books reviewed in this issue may be obtained from the Book Dept., *Tappi*, 122 East 42nd St. New York 17, N. Y.

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Calendar of TAPPI Meetings

NATIONAL

Second Testing Division Conference. Eastman Kodak Co. plant, Rochester, N. Y., September 13–15, 1950.

- General Chairman—James d'A. Clark, Longview Wash.
- Fibrous Materials Testing Committee—E. R. Schafer, Forest Products Laboratory, Madison, Wis., Chairman.
- Nonfibrous Materials Testing Committee—J. P. Casey, New York State College of Forestry, Syracuse, N. Y., Chairman.
- Wax Testing Committee—A. M. Heald, Marathon Corp., Menasha, Wis., Chairman.
- Pulp Testing Committee—L. V. Forman, Institute of Paper Chemistry, Appleton, Wis., Chairman.
- Optical Properties Committee—A. H. Croup, Hammermill Paper Co., Erie, Pa., Chairman.
- Microscopy Committee—C. E. Brandon, Aetna Paper Co., Dayton, Ohio, Chairman.
- Paper Testing Committee—A. K. Warner, Skinner & Sherman, Inc., 246 Stuart St., Boston, Mass., Chairman.
- Container Testing Committee—W. J. Balster, Don L. Quinn Laboratories, Chicago, Ill., Chairman.
- Chemical Methods Committee—Milton Fillius, Eastman Kodak Co., Chairman.
- Packaging Materials Testing Committee—L. E. Simerl, Marathon Corp., Menasha, Wis., Chairman.

Fifth Engineering Conference of the Pulp and Paper Industry. Netherland Plaza Hotel, Cincinnati, Ohio, October 2–5, 1950.

Plastics Conference. New York State College of Forestry, Syracuse, N. Y. October 19–20, 1950.

Alkaline Pulping Conference. George Washington Hotel, Jacksonville, Fla., October 25–27, 1950.

Fibrous Agricultural Residues Conference. Northern Regional Research Laboratory, Peoria, Ill. November 12–13, 1950.

LOCAL SECTIONS

Maine-New Hampshire Section and New England Section:

June 23–24, 1950, Wentworth-by-the-Sea, Portsmouth, N. H.

Empire State Section:

June 25–27, 1950, Thousand Islands Club, Alexandria Bay, N. Y.

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